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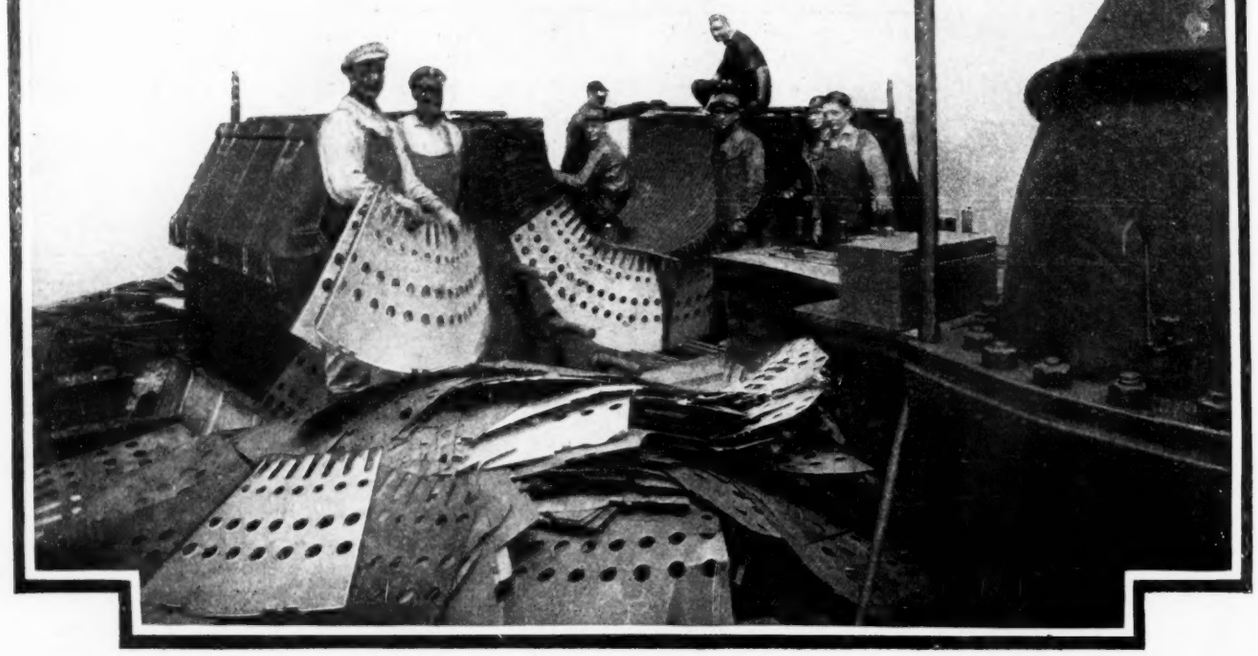
No steam-plant owner would permit his money to be burned up in this fashion—

Yet there are many who view this state of affairs with complacency.

REBUILDING 25,000-KW. GENERATOR

By

Thomas Wilson



ALMOST interesting and difficult piece of work that required turning the generator to a vertical position to receive the new laminations was greatly complicated by the fact that the machine, whose total weight exceeds 200 tons, had to be up-ended within the space of its own foundation, which necessitated raising it a distance of 4½ ft. before turning it.

Readers of *Power* will remember that early in 1914 the English Parsons unit for the Commonwealth Edison Co., of Chicago, was put into commission in Fisk Street Station. At the time the unit created marked interest for two reasons —the generator was the largest that had been built, and the steam-rate guarantee was the lowest ever offered. It was rated at 25,000 kw. and at four-fifths load was designed to deliver a kilowatt-hour on 11.25 lb. of steam, based on steam conditions of 200-lb. gage and 200 deg. F. superheat at the throttle, and an absolute back pressure equivalent to 1 in. of mercury. In practice the turbine is reported to have bettered the guarantee. and its operation was so satisfactory, that it provided a stimulus that led American manufacturers to design machines that now surpass the record of this unit.

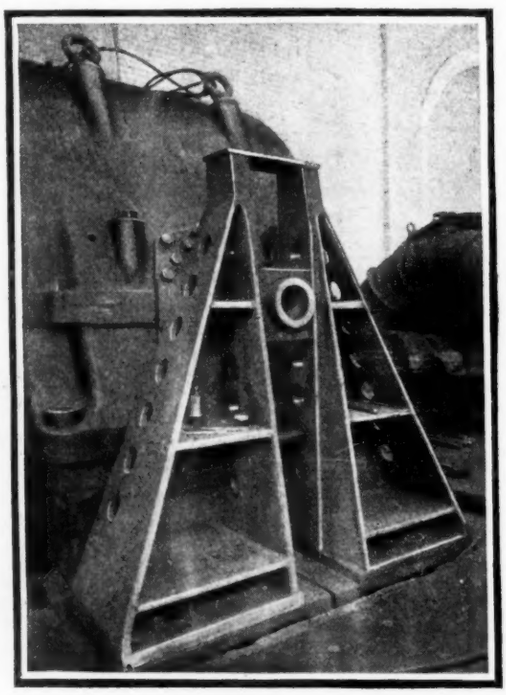
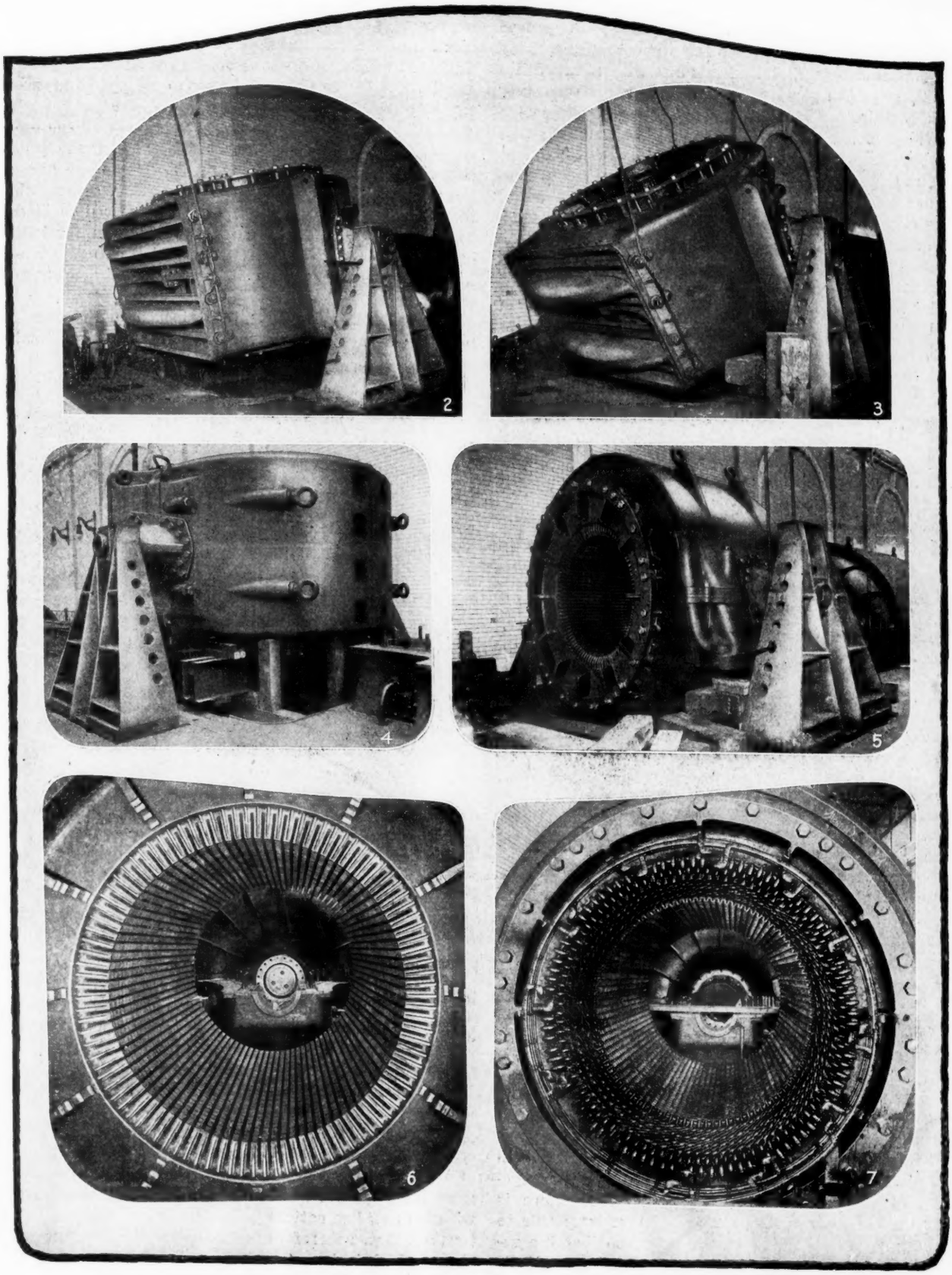


FIG. 1. A-FRAME PEDESTAL AND TRUNNION BOLTED TO SHELL OF GENERATOR

Continued operation brought out the fact that the turbine had capacity in excess of rating, the indications being that it was capable of developing 30,000 kw. The urgent necessity for additional generating capacity and of a higher efficiency than that to be obtained from the older generators in the station made it advisable to utilize the full power of the turbine by providing it with a larger and more efficient generator. Whether to install a new 30,000-kw. generator or to rewind the older one for that capacity was an interesting problem, which was finally decided in favor of the latter alternative. The two prime factors affecting the decision were time and cost. With the electrical industries crowded with war work and transportation facilities overloaded, prompt delivery of a new machine could not be expected. Current quotations for a generator of this size were nearly double those of 1914, so that



FIGS. 2 TO 7. VIEWS OF HOW MACHINE WAS HANDLED WHEN BEING REBUILT

Fig. 2—Turning armature to vertical position. Fig. 3—Armature being turned back to horizontal position with laminations and clamping rings in place. Fig. 4—Armature blocked in place rea dy for restacking. Fig. 5—Lowering armature one side at a time. Fig. 6—Looking through armature at central bearing of unit. Fig. 7—Armature windings in place.

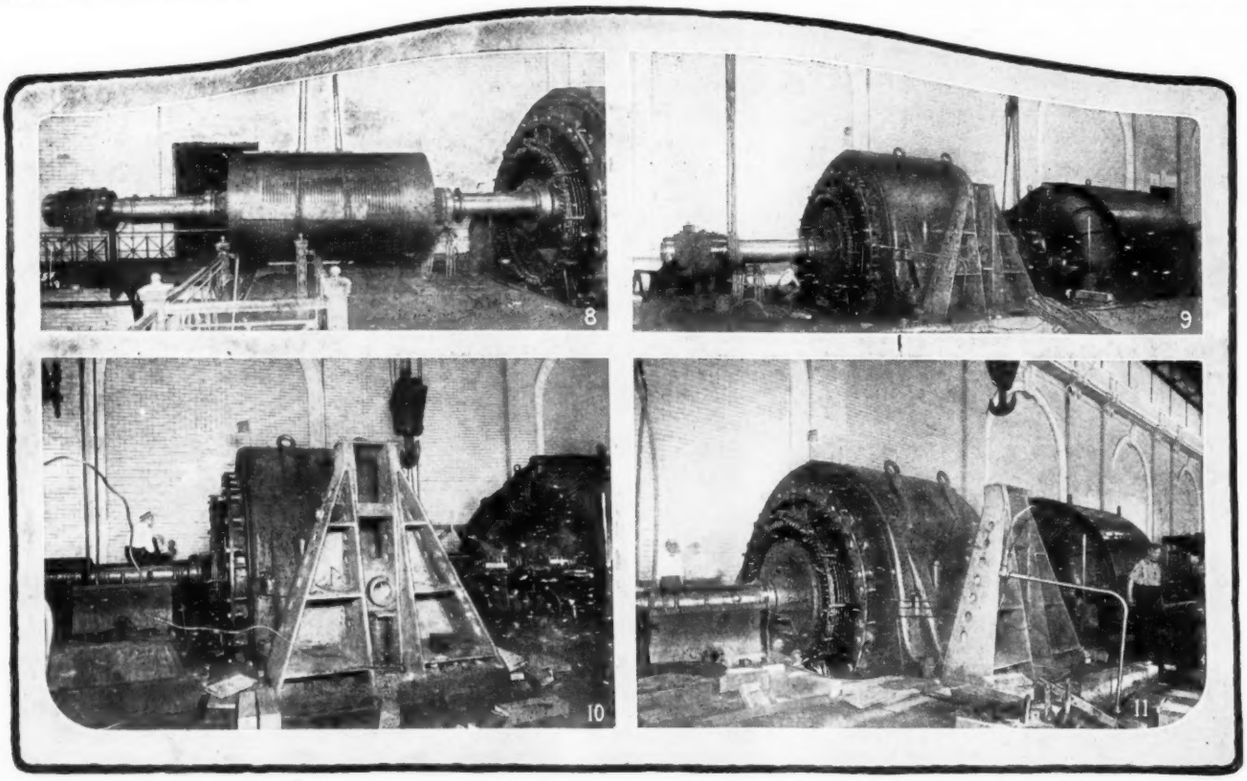
here also it was estimated that the advantage lay in favor of revamping the old machine, and as a matter of fact the cost per kilowatt of increased capacity proved to be less than the unit price for a new machine.

To rebuild a generator of this size with the facilities available in the plant proved to be a very interesting task, but also a difficult one. The contract was accepted by the General Electric Co., with the stipulation that the handling and placing of the machine was to be done by the Commonwealth Edison Co. The method of procedure was suggested by the engineers of the General Electric Co. and was worked out by the engineering department of the operating company, who designed the handling rig and arranged for providing the necessary equipment. The execution of the work was carried out under the supervision of this department, and the General Electric Co. supplied the necessary men familiar with this class of work.

the armature windings and the laminations. The headpiece shows the general outline of the laminations and the openings in them for ventilation and gives some indication of the immense number that had to be handled. The total weight of these stampings was over 58 tons, and in addition to them eight tons of copper and two tons of brass were also removed.

As the initial step in the reconstruction work the top part of the armature casting was refitted to the bottom half of the frame and secured by dowel pins and additional bolts. A cast-steel ring on each end, secured to the frame by twenty-eight 2½-in. bolts, served to bind the two halves more firmly and hold the new laminations in position. To place and secure the latter, new dovetail strips on the inner surface of the frame were essential.

Before the new iron could be stacked in the armature, it was necessary to turn the frame on end, and



FIGS. 8 TO 11. DIFFERENT OPERATIONS IN THE REASSEMBLING OF THE ALTERNATOR
Fig. 8—Moving field into armature. Fig. 9—Field in position, machine ready to lower. Fig. 10—Oil jacks supporting armature. Fig. 11—Generator lowered on its foundation

As is common with large units, the generator is of the revolving-field type. It was originally a three-phase 25-cycle 4500-volt machine delivering through auto-transformers to a 9000-volt bus. The armature was of the closed-slot type and the frame was split on the horizontal diameter. The new design called for a 9000-volt generator delivering directly to the bus, for a frame in one piece, open armature slots and a different arrangement of ventilating ducts. A noteworthy feature is that the General Electric Co.'s engineers were able to so design the rebuilding of the armature that the revolving field required no remodeling, and the direct-connected exciter required only to have its field rewound.

To rebuild the armature it was necessary to take off the top half of the frame, remove the field and tear out

owing to limitations in floor space this had to be done on the generator's own foundation. The shape of the casting was such that, to obtain clearance for turning it, the frame had to be raised 4½ ft. above the foundation.

The turbine room is equipped with two traveling cranes, one rated at 50 tons and the other at 60 tons; of these only one could be brought into play during the greater part of the work. The weight of the armature with the new laminations in place was estimated at 132 tons and it was therefore necessary to provide a special rig on which to turn the frame from the horizontal to the vertical position and back again. This consisted of two double-A-frame pedestals, one of which is clearly shown in Fig. 1, the other being in position at the opposite side of the generator. The vertical legs were pro-

vided with holes at various distances above the base for a 4-in. steel pin to carry a bearing block through which in turn passed the journal of a cast-steel trunnion that had been bolted to the frame of the machine. At the floor level these pedestals were bolted to cast-iron brackets rigidly secured to the cast-iron foundation of the generator. The pedestals and the supporting brackets weighed 16 tons, and the trunnions one ton each. The latter were secured to the frame by 22 two-inch steel bolts, and back of them inside of the frame were placed reinforcing plates to distribute the strain as much as possible. The metal of the legs through which the pins passed was 3 in. thick. To insure a fair bearing for the immense weight to be supported the holes were carefully ground.

When the empty shell of the generator, weighing 62 tons, was ready to be turned, it was raised to an elevation of 4 ft. 6 in. above the floor by the 60-ton crane. The supporting pins were then inserted in the pedestals under the bearing blocks, and the frame was turned on the trunnions to a vertical position by means of one of the cranes, which had been hitched to the bottom of the casting, as shown in Fig. 2. As indicated in Fig. 4, it was then held in this position by heavy timbering and blocking. The new laminations were placed and pressed into position in the usual manner. Including the spacing blocks, bolts, etc., the new iron added 70 tons to the weight of the frame, making a total weight of 132 tons to be supported by the pedestals. Later the armature windings, consisting of 96 coils, which were placed when the armature was turned back to the horizontal position, added another 6½ tons, so that the total weight of the armature exceeded 138 tons.

Lowering the Frame One Side at a Time

When the stampings were in place, the frame was again turned on the trunnions until it once more occupied a horizontal position, the crane being used for this operation, as shown in Fig. 3. As its weight was now 132 tons, or double the capacity of the larger crane, the frame had to be lowered one side at a time. The crane was hitched to one trunnion, taking one-half the weight of the machine. The pin on that side was removed and transferred to the next hole, 9 in. below, and the machine was lowered until the trunnion bearing block rested on it. The operation is indicated in Fig. 5. The hitch was then changed to the opposite side, the frame being lowered in the same way, first to a level position and then to one step below. Alternate transfers were made until the stator was lowered to within 15 in. of the floor. Blocking of this height had been provided and the frame was lowered upon it, thus releasing the pins under the bearing blocks from service and allowing their removal. A stop at this elevation was necessary in order that the coupling on the shaft of the revolving field would pass over the center bearing of the unit when the field was later replaced within the armature. This will be made clear from an inspection of Fig. 6. With the frame in this position the armature windings were put into place, whereupon it appeared as in Fig. 7.

The insertion of the field was the next step. It is 6 ft. in diameter, the over-all length of its shaft is 29 ft. and its aggregate weight 65 tons. Fig. 8 shows the rotor as it appeared suspended from the 60-ton crane preparatory to being inserted into the armature. It was carefully guided into the armature bore as far as the hitch would allow, which, as had been determined by previous calculation, was enough to permit the coupling to project on the other side of the frame. It was then blocked temporarily while the 60-ton crane was being transferred to the coupling end of the shaft and the 50-ton crane hitched to the exciter end. With the two cranes in use the rotor was carried through into its proper position within the armature. At this stage the machine appeared as shown in Fig. 9. After the outboard bearing had been slid into place, the reassembled generator was ready to be lowered the remaining 15 in. to its foundation.

Lowering the Generator to Its Foundation

Although the distance was small, this task was the most difficult of the entire operation, requiring delicate manipulation of the facilities at hand. The blocking upon which the frame was resting consisted of pieces one and two inches in thickness. By placing an oil jack under each trunnion bearing block, as shown in Fig. 10, the weight on the blocking was relieved and it was removed piece by piece as the frame was lowered by means of the jacks. The downward movement of the armature, now weighing 138 tons, was thus under complete control and could be effected very gradually. It was necessary to coördinate this operation with the lowering of the revolving element by the cranes. As the 1-in. air gap between the stator and the rotor gave a maximum clearance of only 2 in., the work had to be done step by step, and there was need of unusual precautions to prevent damaging the field or armature. Notwithstanding the difficulties involved, the machine was lowered safely to its foundation and in this position may be seen in Fig. 11.

In accordance with the standard practice of the company six exploring coils were placed in the slots between the coils, for the purpose of obtaining temperature measurements. The three hottest coils were located by test and connected to indicating instruments in the operating gallery, thus giving the attendants constant visual evidence of temperature conditions in the generator.

Giving the Unit the Drying-Out Run

Before putting the unit in commission the usual drying-out run on short-circuit was made, 12.5 per cent. in excess of the normal full-load current being required to give the necessary heating effect. A heat run at 25,000 kw. showed a maximum temperature rise of only 33 deg. C. above the incoming air, and the temperature differential between incoming and outgoing air was 10 degrees.

The results obtained with the rebuilt generator and the successful accomplishment of this work reflect credit upon the designing engineers of the General Electric Co. and upon the engineers who carried out the work of handling and rebuilding.

The rebuilding of the armature was done under the supervision of A. F. Riggs, district engineer, and Charles M. Norman, superintendent of repair shops, for the General Electric Co. W. F. Sims, field engineer in charge of work at generating stations, supervised the work of handling the machine and was in general charge for the operating company.

Instructions for the Fireman

By ASA P. HYDE

The following rules are in substance those which have been prepared for the guidance of the firemen employed in the plant of which the author is chief engineer. Observance of these rules and suggestions will enable the fireman to save much coal that is wastefully burned.

THERE is a right time for covering furnace fires; determine it and fire, so far as possible, while the damper is closed. Cover only one side at a time, and that lightly, not so heavily that a bright fire cannot be seen through the new fuel. Do this as quickly and evenly and with as few scoopfuls as possible and do not overload the scoop. It is a knack to so handle the scoop that the coal will be evenly and easily scattered and cover the fire without bunching it and leaving it uneven. This requires practice, but it must be acquired. From four to six scoopfuls is enough to cover one side. Do not putter by throwing several half-scoopfuls in, thus keeping the furnace doors open an unnecessary time. Size up the fire quickly, then the quicker and neater the firing is done the more satisfactory the work and the results will be. The inrush of cold air through an open door at firing or cleaning times is ruinous to the entire apparatus, besides lowering the percentage of CO_2. This, by proper managing, can be largely avoided, and it must be done.

Except under extreme conditions always have the ash-pit doors open; this preserves the grates and pits. It is well to carry some water in the pit, but not enough to make a nuisance in the ashes.

Keep the fires back to the inner edge of the dead-plate and allow no fire or coal to accumulate on it under any circumstances. This must be observed as it saves the plates, doors, brick, fronts, etc. Furthermore, coal lying there is simply wasted. Keep the floor clean at all times, and allow no coal to stand either in front of the arches or on the floor of the bin, to be tracked in on the floor. This will serve to lessen the work of cleaning up in the plant. All firing is to be done from the coal car.

Burning Fires Low or Out

Do not allow the fire to burn out or too low or holes to form in it. By so doing more fuel will be consumed, as such conditions allow an inrush of cold air through the dead or low spots into the furnace, resulting in more ash, which causes clinkers, and a lowering of the CO_2; it is bad practice generally. Study the conditions and cover when the fire is ready, generally when it is near or at a white heat, at which time a fine white ash begins to rise; that is usually the proper time, but not always, so watch out. Never do this in a hit-and-miss fashion that may suit the convenience. The fires and the results are the first condition. Results cannot be obtained in any other way, and results are what we must have.

Raking, digging and fussing with a fire are generally unnecessary and must not be done except in extremes. Neglect will largely cause the extremes and they must be accounted for. Raking and then covering will not be allowed. There is no excuse for it.

Leveling is practically the same as raking. Keep the fires level by handling the shovel properly. You can do it. The leveling bar and rake are a lazy man's tools, and he simply does with them what he is too slack or incompetent to do otherwise.

Shaking and Cutting Fires

There can be no fixed rule for shaking and cutting fires, but it should be done only when actually necessary, and this does not mean to make up for neglect. Shake or cut down when judgment shows it is best to do so, but if the fires are properly handled it is not best except at cleaning time. With a heavy fire caused by hard running or poor fuel, it is best and proper. Letting a fire die down and then heavily covering it with fuel will make it necessary to shake and cut the fire, but this must not be done.

Carry as thin a fire as practice indicates is best, taking into consideration the fuel, both as to its quality and the quantity used. The percentage of CO_2 obtained will be a good indication, also the load and weather conditions, which will influence the draft and the length of time the damper will remain open. The heavier the fire the longer the damper will remain open and the more ashes will be made. A heavy load will usually require a correspondingly heavy fire. Too light a fire will permit excess air to enter the furnace; too heavy a fire will prevent enough air from reaching the fire. Study the conditions first and fire accordingly. A fire requires study and thought as well as fuel. Give it both.

Cleaning the Fires

Do not raise the steam pressure because you expect to drop it again or cannot hold it. It is bad practice and it is no credit to a fireman, and as the steam chart shows all of this, it is either a credit or a black mark. To clean, burn the fire down; this of course depends on the fire and other conditions. Do not load up the furnace first with a large quantity of fresh fuel to be handled all over and wasted while cleaning. Burn the fire down close, coal lightly and as soon as it is well ignited, cut as experience dictates.

This is generally done by pushing the grate lever back as far as it will go; then rock it ahead to or near the central position and then back again, doing this once or twice, depending on the condition of the fire. This will help to break up the fire and clinkers if there are any. Then pull the lever to the front or to the cutting position and push it back to the center position for dropping the ashes into the pit. Repeat the latter operation if necessary. Do all this quickly with the furnace doors closed and the damper blocked slightly open to carry off the dust. Do not cut too close, as the fresh fire will come down on the grates, which is ruinous as well as wasteful. Level the fires quickly with the hoe or rake, but it is not best to be too particular at this time. Cover very lightly all over with fresh coal and close the doors as quickly as possible. Then when the fire has burned up and the damper is again closed, level with the leveling bar or rake as needed.

In all cases avoid fussing or digging at the fire. Be quick. It is not the mark of a good or profitable fireman to be always at work at the fires or to have the hoe and poker red hot and burned up halfway to the handles. The one who sees and works quickly and then lets his fire alone to do its part is the successful fireman.

Be continually on the watch. Study your work and the results obtained. It will vary and what will do today may not work at all tomorrow. Avoid continually opening your doors to look in. If you watch the conditions, you should know what is taking place inside without having to continually look in. Do not be bothered by anyone when the fires or apparatus need your attention; to do so will cost us money.

Generally, the wastes in or around the boilers are equal to or more than all other plant losses combined. In our case help to cut them out.

The Damper Regulator

So manage the fires as to keep the damper closed as much as possible. It was not put on to see how many times it will open and close. Help it out by doing your part. It alone cannot do the work. Use your head, and the regulator will make your work less. In connection with the main damper and regulator, use the hand uptake damper on each boiler, depending, of course, on conditions as to how much—but use it. Hold the heat in the arches, so that the boiler may absorb it. The combination of yourself, damper, water level and fire produces the steam chart and the results we want.

Wet the ashes in the pit just enough to hold the dust, but not enough to be sloppy. Take them up as soon after cleaning as possible. Fill the cans full, but do not pound the ashes in or overload. What you may save in this way will be taken out of the cans in handling, and they cost money. Be fair in loading them evenly so as to get as even an ash percentage as possible.

Always have a regular and continuous feed, not on and off, which produces poor results. Carry about four inches of water in the glass and keep it in there—not by continually changing of the water valve, but by so graduating it that it will carry at a fixed point. A steady feed is economy.

Remember that your boilers, if neglected, are as deadly as dynamite to you and to the building. Blow the water columns and glass regularly and know they are all right. Watch the entire apparatus—boilers, walls, arches, grates, steam and water lines, etc.—and report if anything is needed or irregular.

Carry the steam pressure steady. Uniform pressures are economy. Variations are expensive as to fuel and ruinous to the apparatus. The continual expansion and contraction on the apparatus both in the plant and in the building will in the end cause trouble. Positively, it must be avoided.

Providing the best and cheapest fuel for the plant requires your coöperation, both in the use of the fuel and in carefully and understandingly handling and checking it up. Let all work together.

Preventing Smoke and Gases

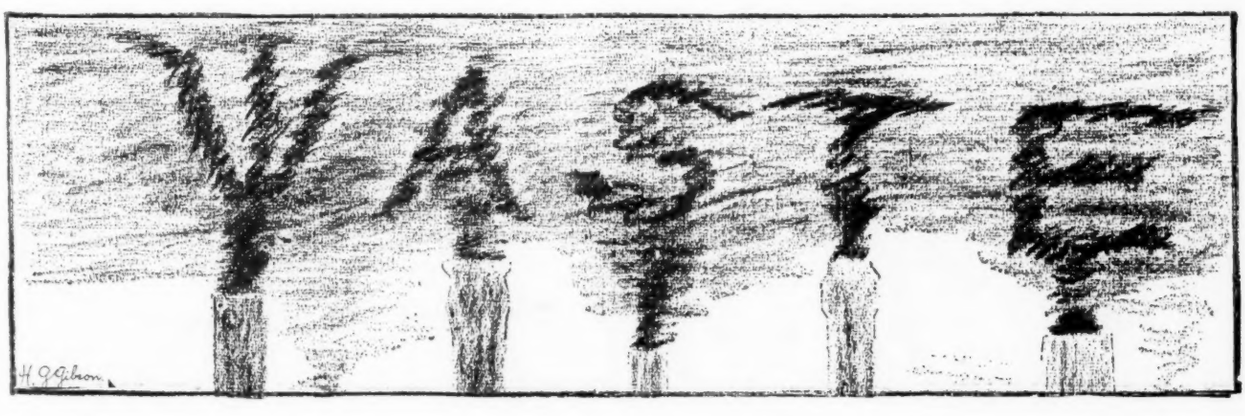
Smoke and gases can be largely if not almost entirely prevented by using good judgment in handling the fires. Fire only when a fire is ready and conditions tell you it is the time—one side only at a time, so far as possible, always lightly, when the damper is closed if possible and not just as it is about to open. In this way the gases from the fresh fuel will be ignited by the live fire and burned in the combustion chamber. The boiler will absorb the heat, and no gases (CO) will escape unconsumed.

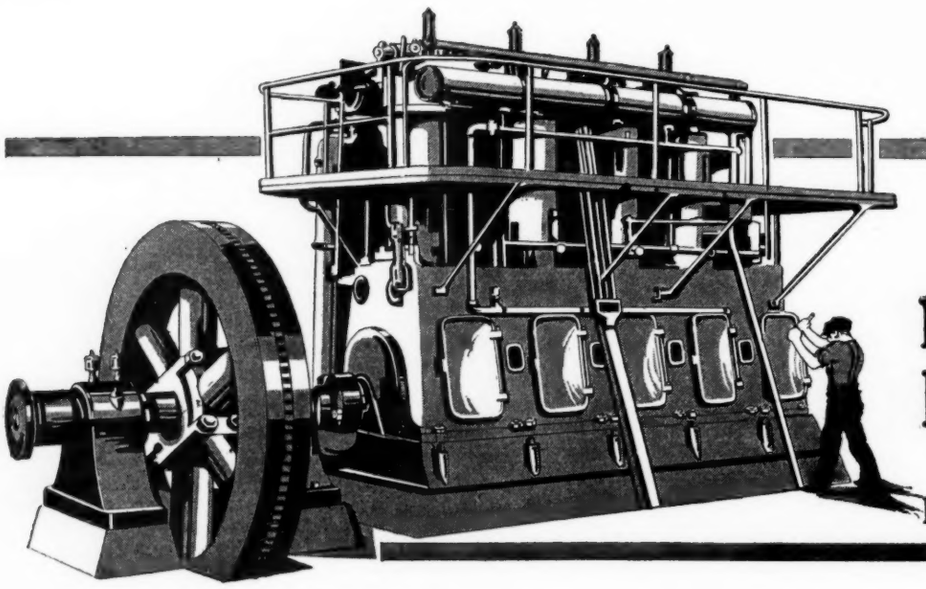
No one can tell you all the kinks that go to make successful firing possible. You must study, read and watch for results. Note carefully what results each change or method produces. Different boilers, different conditions and especially different fuels, require different handling. Carefully study them and determine what is best. Have a system, then follow it.

General Attention

The management has a right to expect the men in charge of the boilers or plant to be careful, conscientious and saving in all ways, both in labor and materials, to give the entire apparatus their careful and strict attention, live up to the rules, and to work for the interests of the men who employ them. Read books and papers in the engineering line. Firing, as well as running, is a trade, and it is so considered by the best engineers.

Do not be content to be a mere "coal shoveler." Be a fireman on your way up to a better position. Make room for yourself at the top. It is up to you. Then your services will be in demand. The company will do the best it can by you and treat you like men. In turn do your best by them and do not expect to stay and give them 95 cents' worth of work or knowledge for a dollar, any more than you accept it as your pay. With our combined efforts we can make our plant profitable and a credit to all. I know that you will help to do it.





Talks on DIESEL Engines

by L. H. Morrison

III—Egan goes into the details of rebabbitting worn-out bearings, advises against peening the metal, but urges that the bearings be scraped to fit the shaft snugly, unless the condition of the shaft makes this a waste of time.

AT THE next session of the Deisel-engine study class Kelly was the target for a broadside of inquiries as to how he was making out with the erection of the second-hand engine.

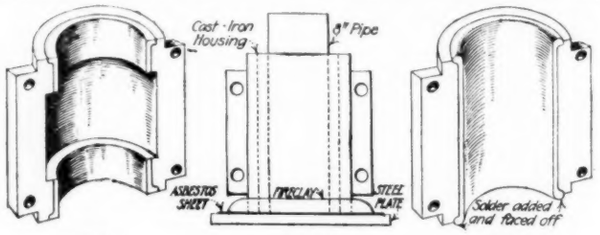
"Well," said he, "I got the frame onto the foundation and grouted in dead easy; but when I started to put the cylinders on the frame I sure ran smack up against a hard one. They had a pair of half-ton duplex hoists, and I was afraid that a cylinder would be too much for one. So I fastened a chain around two of the studs and hooked the two hoists to the ends. It was a tough job to get the men to pull alike so that the load would be the same on each hoist, but we did it and saved them from having to buy a larger hoist."

He turned to Egan, who had been a silent listener to his story.

"One thing does bother me, J. R.," he said, "and that is, the main bearings. I haven't lined up the engine or put in the bearings, but I unpacked them. Two of the middle ones are in bad shape. It looks like I'll have to run them over. The worst thing, though, is that the bearings are shorter than the distance between the crank throws. I can't see how I can fix that without running all the boxes again. If I don't, there is going to be a lot of side play."

"Well, Kelly, the running of a new bearing oughtn't to be hard for you. I'd suggest, however, that in making the new bearings, you change them from the style now on the engine. You understand that on a vertical engine the pressure is always downward. The upper half of the bearing has practically no pressure on it and so it needs only a small surface in contact with the shaft. Some builders make the upper half along the lines of this sketch (Fig. 1). You will note that the babbitt metal is placed at the ends only, resulting in a saving of some twenty dollars per bearing.

"In running a new bearing, get a large ladle (if you can't find a large one, get a cast-iron kettle), place the cast-iron bearing in the ladle over a hot forge and melt out the old babbitt. After the cast iron has cooled, clean it thoroughly and tin it. The idea of the tinning is to make a good bond between the babbitt and the cast iron. Many a bearing is ruined because of the neglect to do this. Then get a steel plate or a heavy smooth timber, lay a sheet of asbestos on top of this timber, set the bearing on end, as I have shown in Fig. 2, and seal the lower edge with moist fireclay. Next get a piece of pipe from the scrap pile. In this case the shaft is 9 in. in diameter, so a short length of 8-in. pipe will do fine. After centering this in the box, you are ready to run the bearing. If you decide to save some babbitt on the upper half, all you need do is to fill in the box with fireclay, leaving the ends clear."



FIGS. 1 TO 3. METHODS OF BABBITTING BEARING CAPS

"What about heating the bearing before running the babbitt?" Kelly asked.

"If you want to make a real bearing, you certainly want to heat the cast-iron housing before you run in the babbitt. If you get it good and hot, it will hold enough heat to let you set it on the asbestos sheet and center the pipe. Heating helps the babbitt to get a better grip. As you have noticed

Next week Egan will describe various types of connecting-rods and the methods used in adjusting them. He will also explain to the class how piston pins should be ground and lapped.

on our jobs here, the babbitted box is next bolted to the carriage of the lathe and bored out with a boring bar. A serviceable one can be made of 1½-in. cold-rolled shafting with a single-ended tool held in a slot by a setscrew. It is easy to level the box on the carriage so that the bore will be true.

"Another important detail," continued Egan, "is the radius or chamfer at the ends. I always feel that this chamfer can best be made with a scraping tool. Make it uniform around the bearing and get the radius big enough so that the fillet will not scrape on the crank throw. Notice that I've made no mention of peening the babbitt. I have noticed that many peened bearings show a tendency to leave the cast iron and the surfaces show fine cracks. The hammer evidently compresses the surface and causes the hardened or compressed portion to expand at a rate different from that of the babbitt nearer the cast iron. Even though engine manufacturers are practically unanimous in this peening practice, you'd better avoid it."

"I've examined the shaft and I don't believe it will pay to scrape the new bearing to fit the shaft," Kelly broke in.

"I dropped by the refinery at noon today," said Egan. "That shaft is so worn you'd never get results by scraping. But I believe that every bearing should be scraped to a nice fit, if the shaft condition doesn't make this impossible. In my opinion it's a poor engineer who will not take this trouble when there is so much invested in the Diesel engine.

"Now, as to the end play, since the faces of the bearings are worn, I'd suggest you clean all the bearings thoroughly. Get some muriatic acid and swab the entire box, tin the faces and run a thick ridge of good solder on the faces, covering the cast iron, as in Fig. 3. Take the bearing to the lathe, bolt the halves together, and true up the faces. Be sure to leave enough solder so that the clearance between crank throw and bearing face is correct."

"You have me there, chief," confessed Kelly. "What is the correct clearance?"

"That depends on the make of engine. In the one you are erecting, since it is pretty well worn, a clearance between the crank and bearing of fifteen-thousandths on each side would not be too much. But bear in mind that it is only necessary to correct the clearance on one bearing. One is enough to take up all side thrust. If it were new, I would think that five-thousandths clearance on each side would be about right. If it were a four-cylinder engine, such as the one we have here with the A frame, you could allow 7½-thousandths and still be safe. On the other hand, I notice that on some two-cylinder horizontal engines the clearance is around a hundredth of an inch. One erector who was here claimed that all the clearance necessary was a running contact, say two-thousandths; but I'd not care to work so close, for I hate to repair bearings."

Again Kelly interrupted. "What I don't see is why there is side play at all. It looks to me as if the connecting-rods can't move sideways and so the shaft must stay in one place."

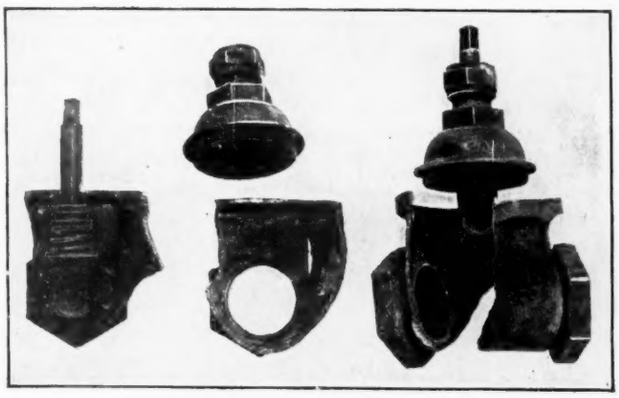
"That sounds all right," admitted the chief, "and I can't tell you why there should be side play. But I do know that I've never seen a direct-connected generating set of this kind that didn't have a sideways motion. I always thought that the harmonic-wave form of the current and its inductive effect on the rotor produced the side-to-side movement, but I wouldn't want to say that that's the right explanation."

A reminiscent look suddenly flooded his gray eyes. He arose, threw away the stub of his cigar and concluded the session by saying:

"I remember a case where we had a generating set that developed this side play, and one of the electricians suggested we move the stator frame sideways an inch, so as to bring all the thrust or pull on one side of the bearing. It worked all right; in fact, it worked too well, and as a result I had a bearing face to build up. The best plan is to allow some play."

Gate Valve Exploded

The illustration shows a 2½-in. gate valve that exploded while two workmen were attempting to remove a close nipple from one end. The valve had been stored in the warehouse, for nearly a year. In order to remove the nipple without damaging the valve the



PIECES OF EXPLODED VALVE

mechanic and his helper put the valve in a portable forge fire and proceeded to heat it, the mechanic holding the valve by the end of the stem with a pair of tongs while the helper turned the blower. Without any warning the valve exploded, the two pieces of the body and one disk going in opposite directions to the right and to the left and away from the workmen, one part carrying away the hood of the forge. The bonnet and stem blew toward the workmen, striking the helper on the arm, and a sliver of brass entered his eye, causing the loss of the sight. The explosion also turned the forge over.

The valve was tightly closed and the pressure built up within the body was prevented from escaping by the two disks and the stem packing. It is not known whether there was any moisture trapped in the body of the valve before heating.

Considerable has been said recently about fabricated ships, and perhaps with not a very clear idea as to the meaning of the term. A fabricated ship is one on which the work of punching and shaping the plates and shapes, and to some extent assembling and riveting, is done at the works before they are forwarded to the shipyards.

Heating Versus Power Boiler Rating

By P. J. DOUGHERTY
Chief Engineer, International Heater Company

The object of this article is to show that the rules in general use for determining and comparing the rating or capacity of high-pressure boilers are not applicable to low-pressure or so-called heating boilers, and why. Almost all conditions of design and operation are different.

FEW high-pressure engineers concern themselves with the rules by which they can compare the capacities of different types of heating boilers. Heating engineers had no reliable rule until recently, when the American Society of Heating and Ventilating Engineers established its Heating Boiler Code. While the same principles apply to both heating and power boilers, their design and the conditions under which they operate differ radically, hence their requirements as to capacity and operation vary greatly. Fundamentally, each type consists of a furnace and a boiler proper; the furnace generates heat from the fuel, and the boiler generates steam from the heat and water. The importance of a dome or a space in which the steam and water are separated is often overlooked in heating-boiler design, and some cast-iron boilers require an expensive pipe header to do this separating. Modern cast-iron and power boilers separate the steam from the water within the boiler itself irrespective of the number and size of the flow outlets or whether the velocity of the steam is high or low, provided there is no extreme and sudden drop in pressure.

A Heating Boiler's Capacity Cannot Be Determined on a Grate-Area Basis

Unless the engineer realizes wherein the requirements of a heating boiler differ so radically from those of a power boiler, he will frequently do a great injustice to his friends who seek his advice as to the best boiler to buy. It is a simple matter to determine the capacity of a power boiler. According to Kent, "It is a general practice among builders to furnish from 10 to 12 sq.ft. of heating surface per horsepower, and not less than ¾ sq.ft. of grate surface should ordinarily be furnished per horsepower." A rated boiler-horsepower is considered equivalent to 138 sq.ft. of direct steam radiation, but no such rule can be applied to heating boilers because there is no such uniformity in "general practice among builders" of heating boilers. In fact, there is such a wide difference in the numbers of square feet of heating and grate surface per hundred feet of radiator capacity among the leading makes of heating boilers that in comparing their relative capacities one may as well compare the relative areas of their fire-doors or smoke-pipes as their relative grate areas or heating surface, as will be seen by Table I, of grate areas, compiled from the current literature and catalogs of prominent heating-boiler manufacturers. It proves that it is a waste of time and effort to attempt to determine a heating boiler's capacity on a grate-area basis, and the following list might be extended indefinitely. The sizes fall into three groups, averaging practically 5, 10 and 18 sq.ft. respectively. In the first group there is less than one square foot difference of grate areas between the 900-ft. and the 2000-ft. boilers. In the second group the 4800-ft. boiler has a smaller grate than the one rated at 2275 sq.ft. In the third group the 800-ft. boiler has a smaller grate area than the 4200-ft. boiler, nearly all of the boilers being widely known and in general use.

TABLE I. GRATE AREA VERSUS CAPACITY

Grate, Sq.Ft.	Rating, Sq.Ft.	Grate, Sq.Ft.	Rating, Sq.Ft.	Grate, Sq.Ft.	Rating, Sq.Ft.
4.90	1,100	9.36	1,950	17.50	6,000
4.90	1,290	9.50	3,600	17.50	7,350
4.90	1,400	10.00	2,900	18.00	5,275
4.98	900	10.00	3,250	18.00	5,300
5.63	1,200	10.00	4,800	18.00	5,400
5.63	1,400	10.50	2,800	18.00	5,850
5.63	1,500	10.50	3,250	18.00	6,300
5.63	1,650	10.50	3,500	18.00	6,800
5.83	2,000	10.50	3,600	18.00	8,000
5.84	1,575	10.92	2,275	18.24	4,200

Lack of definite relation between grate area and rated capacity does not necessarily indicate improper ratings. It merely proves that the grate-area rule borrowed from power practice never had and never will have any practical value or application to low-pressure boilers, as a study of the table shows. The grate-area rule does not even apply to all boilers made by the same company, much less to those made by different companies. Many magazine articles and books on heating and ventilation contain elaborately worked-out rules and equations to determine a heating boiler's capacity by its grate area. Such rules are not only worthless but misleading, since they are based on wrong principles and cannot be made right. The new Heating Boiler Code has superseded all such rules.

Only Actual Tests Will Determine the Relative Merits of Different Heating Boilers

Books and articles also contain elaborate rules and equations for the amount of heating surface boilers should contain. Such rules are generally based on power practice that a square foot of heating surface develops about three pounds of steam per hour. It is anything but scientific to attempt to establish a rule or law on such flimsy premises as assumption and analogy, which have been the only foundation for these rules when applied to heating boilers. Because the factors and conditions operating in each case vary so widely, what a square foot of heating surface in a B. & W. or a Scotch marine does is no criterion as to what a square foot of heating surface in heating boilers may do, and what a square foot of heating surface does in one heating boiler is no criterion as to what a square foot of heating surface will do in another one if designed along radically different lines. The only way to determine the relative merits of any two heating boilers, irrespective of their relative grate or heating-surface areas, is by actual tests, according to the boiler code of the A. S. H. and V. E. conducted by a competent and impartial research bureau such as it is hoped this society will succeed in establishing. Until such a time the public must depend upon the capacities given

by the manufacturers, which in some cases are reliable and in accord with the new boiler code.

It may be a surprise to many who have had no practical experience in designing heating boilers to learn that the amount of heating surface in a modern cast-iron boiler is of such secondary importance that the engineer who designs it sometimes does not even know its area. It is the design or rather location of the heating surface and not so much the amount of the heating surface that produces efficiency. The engineer who designs a cast-iron boiler can mold or place the heating surface where it will be the most effective as freely as an artist molds his clay in producing his masterpiece. Not so, however, with the designer of steel boilers. He is so cribbed and confined in the use of shapes because of pressure conditions that he has little or no chance to assert his individuality or make practical application of the latest results of experimental research. Hence very little improvement has been made in the efficiency or capacity of a square foot of heating surface in power boilers during the last century. The progress made along those lines in cast-iron boiler design is so rapid that some of the modern boilers show a higher efficiency and capacity with only one-half to one-fourth of the amount of heating surface of those designed ten to twenty or more years ago.

Heating Surface and Rated Evaporation Capacity

The evaporation capacity in relation to heating surface in power boilers averages about three pounds of steam per hour, which is far below that of a modern cast-iron boiler. It is evident that too much of the heating surface in a power boiler lies too near the zero end of the scale and very little up toward the 100 per cent. end, while almost any heating boiler is required to develop its rated capacity while evaporating about nine or ten pounds of water per square foot of heating surface. Fifty square feet of heating surface in a boiler averaging eight pounds of steam per hour is far superior to two hundred square feet averaging two pounds of steam per hour, there being so much less chance for soot pockets, high draft resistance, short-circuits, less metal to heat up, etc. The excess iron placed in the heating surface of a boiler because of faulty design is so much junk sold at finished-product prices. The less heating surface required to produce the required results the more efficient the design.

The power-boiler heating-surface rule grafted on low-pressure boiler practice has even less practical value in determining a heating boiler's capacity than the grate-area rule, as an examination of Table II will convince the most skeptical. Like the grate-area table, this heating-surface table is compiled from the current literature and catalogs of some of the most prominent heating-boiler manufacturers and the number might be greatly extended.

TABLE II. HEATING SURFACE VERSUS RATED CAPACITY

Heating Surface, Sq.Ft.	Rated Capacity, Sq.Ft.	Heating Surface, Sq.Ft.	Rated Capacity, Sq.Ft.	Heating Surface, Sq.Ft.	Rated Capacity, Sq.Ft.
83	900	116	900	223	5,375
89	1,625	117	2,400	224	1,700
91	1,125	122	1,575	330	4,400
98	700	177	2,300	340	8,350
107	2,100	185	3,675	340	4,550
114	1,400	190	1,400	344	3,000

Notice that the 1700-ft. boiler has nearly three times as much heating surface as the 1625-ft. boiler; the 3000-ft. boiler has more heating surface than the 8350-ft. boiler; the 4550-ft. boiler has the same amount of heating surface as the one for 8350 sq.ft., although both are made by the same company but of different design.

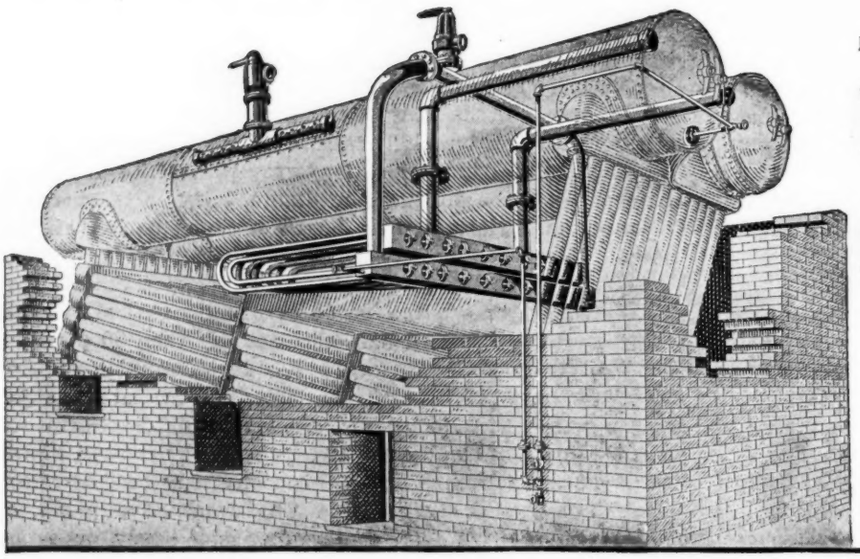
The reason high-pressure boiler rules have no application whatever to low-pressure practice is due not only to the difference in design, but also to conditions of operation, such as length of firing period, kind of fuel used and different draft conditions. In the A. S. H. and V. E. Boiler Code the available fuel, the evaporative power and the length of firing period are factors considered. With hard coal not less than 20 per cent. of the boiler's coal capacity is for continuing the fire, the remainder being considered as available, as per code test. Because of the great difference in the nature and quality of soft coals no such percentage basis can be applied. The coal capacity may be determined by actual measurement. The evaporative power or efficiency, however, can be determined only by actual test according to the boiler code. The available fuel times the evaporative power gives the total boiler capacity in pounds of steam.

Length of Firing Period Important Factor in House Heating

The length of the firing period, while a negligible factor in power practice, is the most important factor in house heating. The total capacity divided by the length of firing period gives the hourly rated capacity. House-heating practice demands an 8- to 12-hour firing period with hard coal. Large boilers for apartments and public buildings are usually rated on a 4- to 6-hour period with hard coal. Soft-coal boilers are rated on an hourly basis because of the nature of soft coal. The available fuel in pounds times the evaporative power in pounds divided by the length of the firing period in hours gives the hourly rated capacity in pounds of steam. The hourly capacity in pounds of steam times 4 gives the rated capacity in square feet of direct steam radiation, since four square feet of direct steam radiation condenses one pound of steam per hour.

The A. S. H. and V. E. in establishing the foregoing excellent rule complied with the golden rule in doing unto the manufacturer as they expect their clients to do unto them. They tell the manufacturer what results they expect from his boilers, but refrain from telling how he should design his boiler in order to produce those results, the number of square feet of grate or heating surface, etc. They, as engineers, likewise look to their clients to tell them what results they expect to get, but insist that the owner keep "hands off" as to how the heating or ventilating system shall be designed in order to produce those results.

It is not beyond the bounds of reason to foresee a condition whereby a householder, in the place of the ton of anthracite that he now welcomes for $11, will receive a ton of smokeless coal without slate, a month's supply of cooking gas, 40 miles of motor fuel, enough fertilizer to start a small garden, and tar sufficient to lay the dust in front of his house—all for far less money than he now pays for inferior coal.



DETERMINATION OF SUPERHEATER SURFACE

by C. H. Baker*

The author gives charts showing the relationship between superheat and the factors that influence it. One of the charts enables the engineer to determine the square feet of superheating surface when the superheater location and degrees superheat are known, or to obtain the degrees superheat when the location and surface are given; or if the surface and superheat are specified, to determine the location. This chart is of size suitable for use in an engineer's loose-leaf data book.

THE present tendency for higher steam pressures forces the superheater into greater prominence, since the degree of superheat must be increased proportionately with the pressure to insure the same degree of dryness of the steam in the turbine as with the lower pressures. Present turbine design will not admit of higher temperatures than 650 deg. F. to 700 deg. F., and maximum power-station economy must be realized with these figures as a limit. Therefore, when the pressure is fixed, the degree of superheat is confined to comparatively narrow limits. Superheaters designed by the rule of thumb occasionally meet their guarantees, but experience has shown that they usually fall below, which may be due to one of many reasons, but since superheaters are usually sold on horsepower instead of a square-foot basis, the usual reason is lack of surface. The simplest and obviously cheapest remedies are to improve the heat transfer in the given surface by readjusting the boiler or superheater baffles, thus increasing the velocity or temperature of the gas, as the case may be, at the superheater, with a consequent reduction in capacity or overall efficiency; or increase the steam velocity by inserting cores in the superheater tubes, which give an increased pressure drop through the superheater and a decrease in the life of the tube. The pressure drop through the superheater also has the effect of cutting down the turbine capacity unless the turbine is designed to carry full load at the reduced pressure. It seems a waste of money to purchase a high-pressure boiler when the pressure cannot be utilized at the turbine on account of the pressure drop through the superheater and piping.

Although superheaters have been manufactured for fully sixty years, available data and literature for purposes of design are meager. Several empirical formulas appeared in both the American and foreign press some ten years ago, of which J. E. Bell's formula in the Transactions A.S.M.E., 29-267, 1907, is typical of all forms and is as follows:

$$S = \frac{10t_s}{2(T - t) - t_s}$$

where

S = Square feet of superheating surface per boiler horsepower;
t_s = Superheat, deg. F.;
T = Temperature of gas entering the superheater, deg. F.;
t = Temperature of dry and saturated steam at boiler pressure, deg. F.

The required superheating surface is governed by the required superheat, the temper-

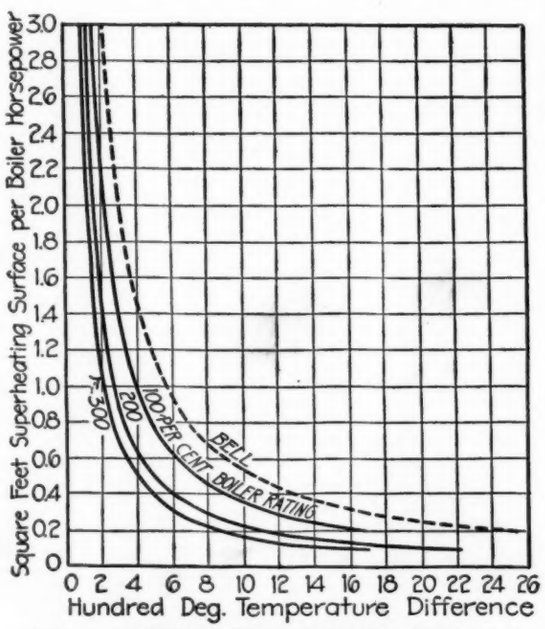


FIG. 1. RESULTS WITH VARIOUS FORMULAS COMPARED WITH BELL'S

*Engineering Department, Public Service Electric Co., Newark, N. J.

ature of the entering gas and steam, the velocity of the gas and steam through the superheater, the quality and quantity of the entering steam and the conductivity and cleanliness of the superheater material.

If there is no heat lost to radiation, the heat balance for the heat taken up by the steam may be expressed:

$$SUt_m = WCt_s \qquad (1)$$

where

S = Square feet of superheating surface per boiler horsepower;

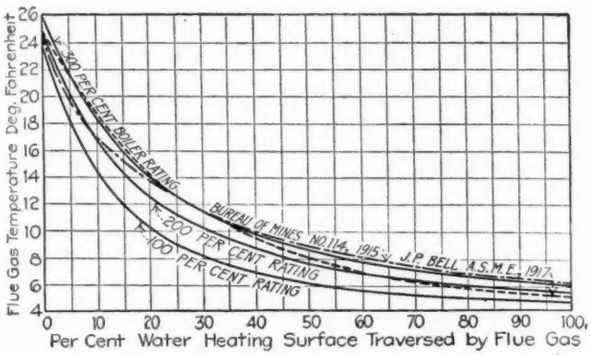


FIG. 2. RELATIONSHIP OF BELL'S AND BUREAU OF MINES FORMULA

U = Heat transfer per square foot per hour per degree mean temperature difference, B.t.u.;

t_m = Mean temperature difference between the gas and steam, deg. F.;

W = Pounds of steam per boiler horsepower passing through the superheater;

C = Mean specific heat of the superheated steam, B.t.u.;

t_s = Superheat, deg. F.;

T = Temperature of gas entering superheater, deg. F.;

t = Temperature of saturated steam at boiler pressure, deg. F.

If T is assumed to be the average temperature of the gas at the superheater and $t + \frac{t_s}{2}$ the average temperature of the steam in the superheater, the arithmetical mean temperature difference, which is sufficiently accurate, may be expressed as follows:

$$t_m = T - \left(t + \frac{t_s}{2}\right)$$

substituting this value of t_m in equation (1) and transposing,

$$S = \frac{2WC}{U} \times \frac{t_s}{2(T-t) - t_s}$$

Bell assumed the value of $W = 30$, $C = 0.5$, and $U = 3$, which values were sufficiently accurate in the early days of low boiler-forcing rates and low steam pressures.

Bell also gives a formula of the logarithmic form for determining the value of the unknown quantity $(T - t)$ where the superheater is to be designed for a new boiler, as follows:

$$\frac{1}{(T-t)0.16} = 0.172H + 0.294$$

Comparison of tests on a modern horizontal water-tube boiler with these formulas, with the superheater located at the top of the first pass, are given below.

Boiler Data:

1375 hp. boiler, 12-foot setting.
1711 sq.ft. superheating surface.
16- retort underfeed stoker.
62 ratio heating to grate surface.

Test Data:

220 lb. = average boiler pressure during test.
t = 369 deg. F. average temperature steam entering superheater.
t_s = 95 deg. F.; T = 700 deg. F. at 100 per cent. rating.
t_s = 124 deg. F.; T = 890 deg. F. at 200 per cent. rating.
t_s = 140 deg.; T = 1030 deg. F. at 300 per cent. rating.

Square feet of superheating surface per boiler horsepower generated:

S = 1.25 sq.ft. per b.hp. at 100 per cent. rating.
S = 0.625 sq.ft. per b.hp. at 200 per cent. rating.
S = 0.417 sq.ft. per b.hp. at 300 per cent. rating.

Let A represent the quantity $\frac{2WC}{U}$ that is contained in equation (2) or the value of 10 in Bell's formula for surface. Then A represents a quantity that varies with specific heat and weight of steam, heat transfer, and steam and gas velocities; all of which fluctuate with the rate of forcing.

Introducing the test values at the various forcing rates in the formula,

$$A = \frac{(2(T-t) - t_s)S}{t_s}$$

we have for the three forcing rates,

A = 6.75 at 100 per cent. rating,
A = 4.35 at 200 per cent. rating,
A = 3.35 at 300 per cent. rating,

and the revised formulas for superheating surface then

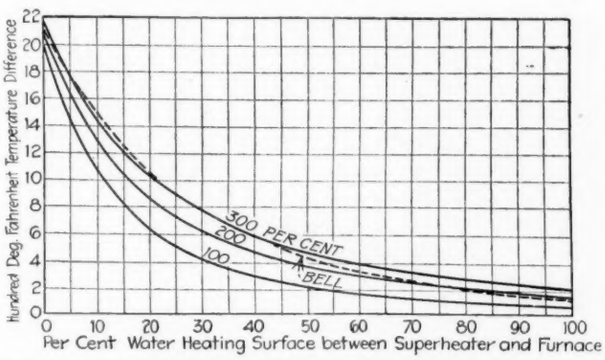


FIG. 3. TEMPERATURE DIFFERENCE OF STEAM AND GAS AGAINST PERCENTAGE OF HEATING SURFACE

become

$$S = \frac{6.75t_s}{2(T-t) - t_s} \text{ for 100 per cent. rating}$$

$$S = \frac{4.35t_s}{2(T-t) - t_s} \text{ for 200 per cent. rating}$$

$$S = \frac{3.35t_s}{2(T-t) - t_s} \text{ for 300 per cent rating}$$

Fig. 1 shows the comparative results from these formulas with Bell's for 100 deg. F. superheat.

The flue-gas temperatures were taken in the furnace, at the top of the first pass or superheater entrance,

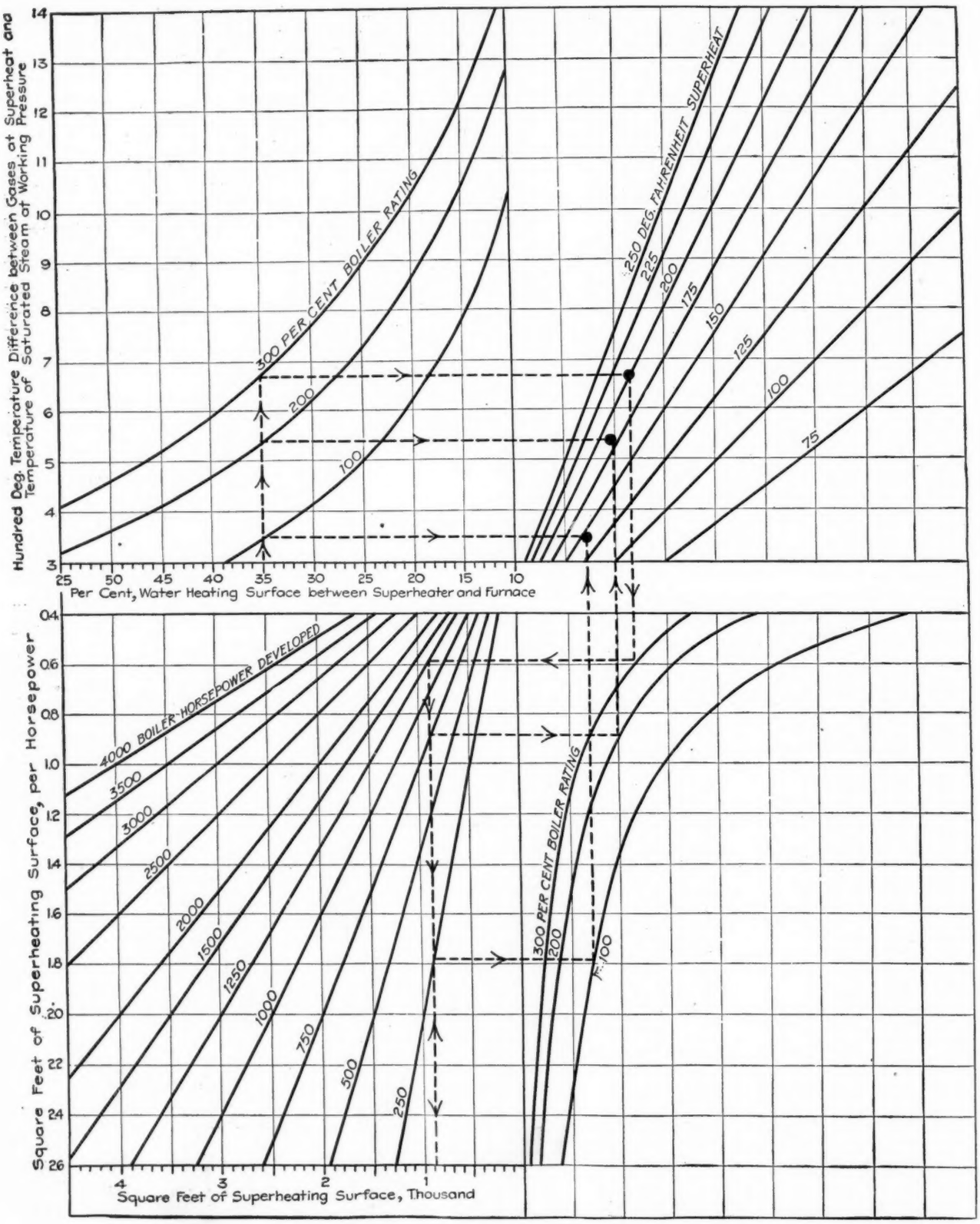


FIG. 4. CHART FOR DETERMINING THE REQUIRED SUPERHEATER SURFACE

at the top of second pass or superheater exit, at the top of third pass and flue. The average values were plotted against heating surface for the various forcing rates and replotted against percentage of heating surface, as shown in Fig. 2, for comparison with Bell's and the Bureau of Mines values. The relationships of Bell's and the Bureau of Mines values with the 300 per cent. curve are almost identical around 30 to 40 per cent. heating surface traversed, which is the usual location for a superheater at the end of the first pass. The test curves were then replotted in Fig. 3, showing the temperature difference of gas and steam against

percentage of water-heating surface and formulas derived for the various forcing rates.

General Application of Superheater Formulas

Fig. 4 is a compilation of the test curves and is drawn up to facilitate the work of obtaining the square feet of superheating surface when the superheater location and degrees of superheat are given; or if location and surface are given, to obtain the degrees of superheat; or if surface and superheat are specified, to determine the location.

Problem: Given a 500-hp. water-tube boiler with a superheater to be located in the first pass. There is 35 per cent. water-heating surface in the first pass, and the superheater must generate steam at 200 deg. F. superheat at 300 per cent. rating. What should be the square feet of superheating surface and what would be the superheat at 100 per cent. and 200 per cent. rating?

Solution: In the upper left-hand quadrant read up from the 35 per cent. to the 300 per cent. curve, then to the right horizontally (noting 670 deg. temperature difference of gas and saturated steam) to the 200-deg. F. superheat line, then down to the 300 per cent. line in the third quadrant, then horizontally to the left to the 1500 hp. line, which is 300 per cent. rating of a 500-hp. boiler; now project vertically down and note that the required surface should be 900 sq.ft., nearly. Required, the degrees superheat at 100 per cent. rating: Project vertically up from 900 sq.ft. surface in the quadrant to the 500-hp. line, then to the right to 100 per cent. rating in third quadrant, then vertically up to the intersection with a line from a point on the 200 per cent. curve directly over 35 per cent. water-heating surface in first pass and note 145 deg. F. superheat. Similarly, to find the degrees of superheat for 200 per cent. rating read up from 900 sq.ft. in the fourth quadrant to 1000 hp., or 200 per cent. load, and note by following the line that it shows 180 deg. F., superheat.

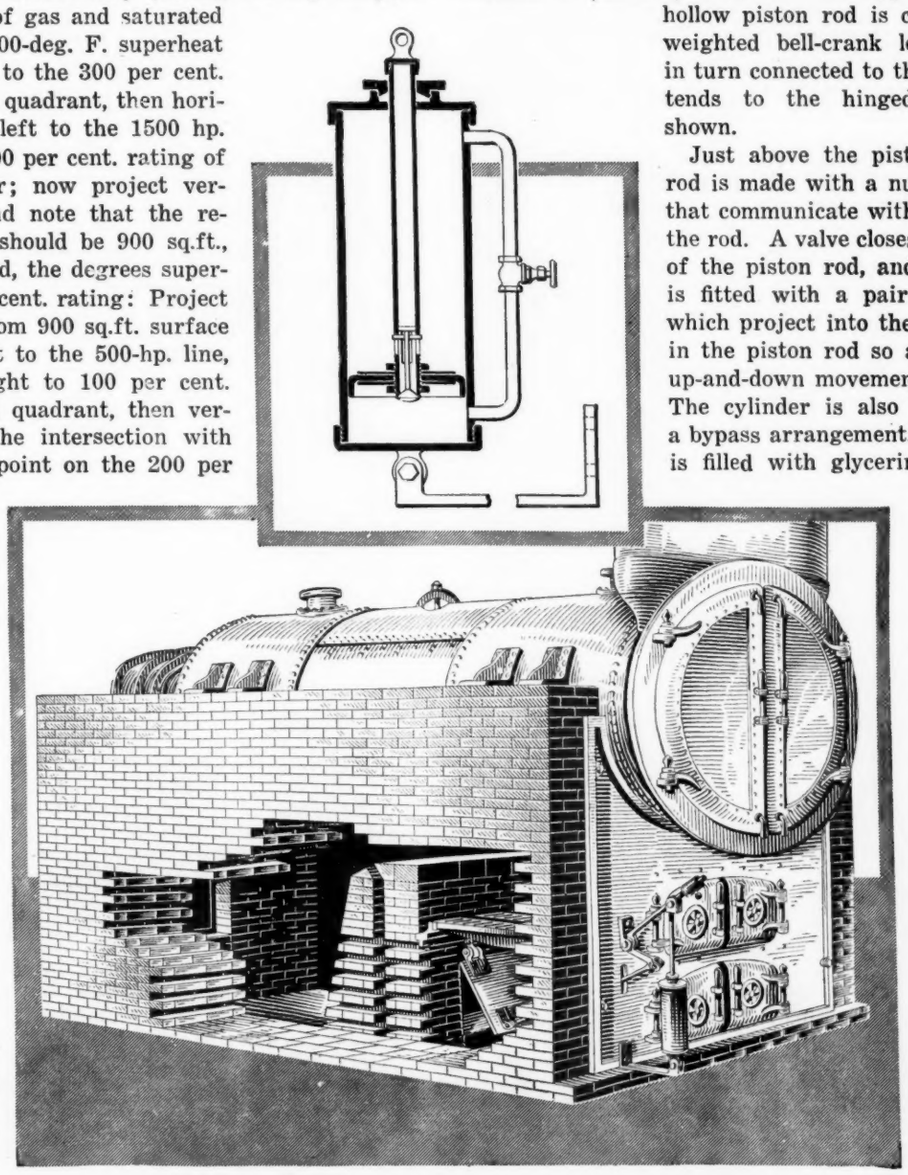
Kosel Smoke Preventer

With the enactment of municipal smoke-nuisance laws attention was diverted to the perfecting of apparatus that would assist in the smokeless combustion of fuel. Many such devices have been invented, one of the latest being the Kosel smoke preventer, patented by Henry G. Kosel, of 405 East 168th St., New York City.

In this particular arrangement, shown in the illustration, the boiler setting is similar to the ordinary method employed, with the exception that the bridge-wall is supplemented by a second one built behind the usual bridge-wall, but so arranged that an air space is left between them. The opening at the top of the bridge-wall is such as to direct the escaping air toward the combustion chamber. Through this chamber the additional air necessary to carry on smokeless combustion is admitted to the furnace.

Control of the air passing through the bridge-wall is by means of a damper hinged on the front face of the bridge-wall, operated by a bell-crank lever and cylinder placed at the front of the boiler setting. This cylinder contains a leather piston, and the upper end of the hollow piston rod is connected to a weighted bell-crank lever which is in turn connected to the rod that extends to the hinged damper, as shown.

Just above the piston the piston rod is made with a number of ports that communicate with the hollow in the rod. A valve closes the lower end of the piston rod, and a valve stem is fitted with a pair of crossarms which project into the shortest slots in the piston rod so as to limit the up-and-down movement of the valve. The cylinder is also provided with a bypass arrangement. The cylinder is filled with glycerin or oil so as to retard the downward movement of the piston, thus acting as a check on the closing of the bridge-wall damper. The operation of the arrangement is as follows: At the time of adding fresh fuel to the furnace the fireman lifts the weighted lever, which permits the glycerin in the cylinder to flow through the port open-



DETAILS OF SMOKE PREVENTER AND APPLICATION TO FURNACE

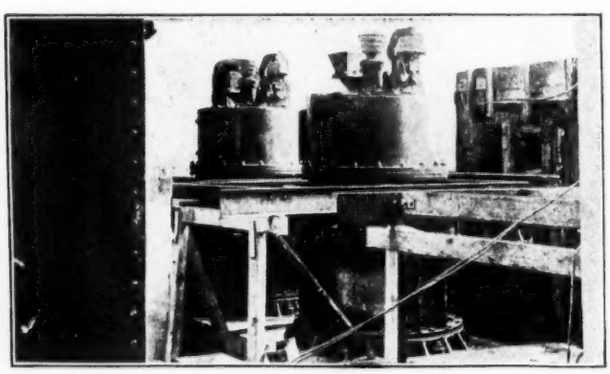
ings in the piston rod against the valve and into the lower part of the cylinder. This lifting of the lever also opens the damper in the bridge-wall, and air is thus admitted to the air space between the bridge-walls. As the weight of the lever forces the piston down, the resistance of the glycerin seats the valve, and the glycerin can escape to the upper side of the piston only through the bypass; and as this is fitted with a valve, the flow of glycerin to the top part of the cylinder can be adjusted so as to cause a longer or shorter time for closing the air damper. By this means the supply of air to the combustion chamber can be regulated so as to maintain smokeless combustion in accordance with the amount of fuel that is fired at one time.

Burning Powdered Coal Successfully

The additional equipment necessary consists of crushing and pulverizing mills, driers, inclosed storage bins together with conveyors and elevators.

AN EXPERIMENT in the burning of powdered coal was carried out recently by the Puget Sound Traction, Light and Power Co. For this test a 300-hp. water-tube boiler at the Western Avenue steam heating station in Seattle was equipped with a "dutch oven." The powdered coal was delivered to an inclosed bunker by bucket elevators. From the bunker the coal was fed by air pressure through pipes and a locally designed burner to the furnace.

Various difficulties were experienced at first, one of the most annoying being the formation of slag on the boiler tubes. This was due to insufficiency in space between the burners and the tubes, with the result that combustion of the solid matter of the coal was not completed in the firebox, but was still going on among the tubes, the stream of burning coal being from 12 to 14 ft. long. Two means were found for correcting this evil, one by furnishing a longer path for the flame and the other by introducing steam into the fire. The effect of the latter was quite remarkable, resulting in a

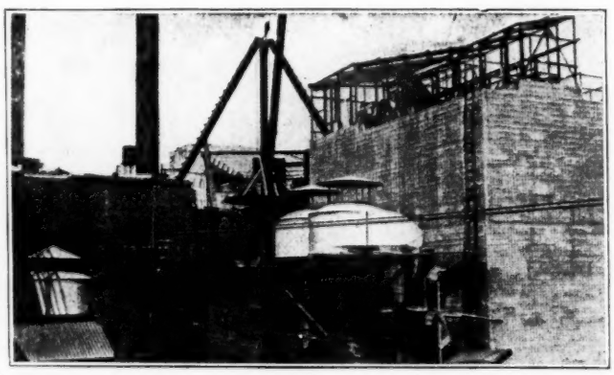


TWO OF THE PULVERIZING MILLS UNDER ERECTION. STEPPED CONE PULLEYS ARE FOR SCREW FEED—DRIVE PULLEYS CAN BE SEEN AT BASE

decrease in flame length of about 50 per cent., the amount of steam required being less than that used for atomization with an oil burner of good design.

With the shortened flame length, the fused portion of the ash is deposited on the furnace walls before reaching the tubes and flows down into the ashpit, leaving a glazed coating about $\frac{1}{16}$ in. thick on the brickwork. Some difficulty was experienced from accumulation of slag in the ashpit in a solid block which required the use of bars to break up. This difficulty was finally overcome by constructing the throat of the slag pit so that the molten slag was forced to drop from the furnace in semifluid masses, and by using a water spray which prevented successive droppings from sticking together. Under this treatment the slag accumulates in the pit in chunks about the size of a large potato and is easily removed with a rake through the usual clean-out door.

This boiler had previously been used with an oil



CYCLONE DUST COLLECTOR—FRAME OF HOUSING FOR BELT CONVEYOR BEING ERECTED ON TOP OF CRUSHED-COAL BUNKER

setting. When fired with oil, it began to show distress at an overload of 50 per cent. With powdered coal as fuel, overloads of more than 100 per cent. were carried without visibly affecting either the brickwork or the tubes. Sub-bituminous coals which give an evaporation of about 6¼ lb. of water per pound on chain grates gave better than 8½ lb. evaporation per pound of pulverized product when burned in powdered form, corresponding to an increase of 20 to 25 per cent. in the evaporative performance of the raw coal.

Almost perfect control of the fire was possible by regulating the speed of the supply fan by means of a rheostat controlling a variable-speed motor. The boiler was equipped with an indicating steam-flow meter, and its responses to changes in fan speed were almost like those of an ammeter on an electric generator.

After three months of operation, during which time all obtainable grades of coal were burned, from high-grade bituminous to the poorest lignites, it was demonstrated conclusively that coal of the character obtainable in this region could be successfully burned in powdered form under steam boilers. It was shown also that the performance of all grades when burned in this way was superior to any other method of firing, the improvements in the case of the lower grades being relatively greater than for bituminous coal.

As a result of these experiments, it was decided to equip the entire Western Avenue plant for burning

powdered coal. As the station was equipped for burning oil, it was necessary to provide coal and ash-handling equipment and storage facilities and to change the furnace design as well as to supply the equipment required for drying and pulverizing the coal.

The New Building and Its Equipment

The pulverizing plant will be housed in a new concrete building adjacent to the station. Coal will be delivered from the bunkers and fed by gravity onto a rubber belt conveyor, which will carry it to a crusher of the single-roll type. This belt will deliver the coal to a vertical elevator of the two-strand chain and bucket type just inside the pulverizing plant. After being crushed the coal will be raised to the roof and distributed to the crushed-coal bunker by a flight conveyor.

The crushed-coal bunker will extend the width of the building and have a capacity of 300 tons. From two openings in the bottom of this bunker the coal will be fed by apron-type feeders to chutes communicating with the driers on the floor below. The spill from the apron feeders will be picked up by screw conveyors and delivered to the chutes, which are to be so arranged that coal can be fed from either end of the bunkers to either of the two driers.

The driers will consist of two steel cylinders, 55 ft. long, one 5 ft. and the other 6 ft. in diameter. They will be slightly inclined to the horizontal and arranged for rotation about the longitudinal axis. Steel baffles will be arranged longitudinally inside, which will successively raise the coal and drop it as the cylinder rotates, thus forcing the coal, because of the pitch, gradually to pass through the drier.

Heat for drying will be supplied by furnaces which will inclose the driers for the greater part of their length. The furnaces will be fired with powdered coal and the gases of combustion will pass into the driers

RAW COAL BUNKERS EXTEND BELOW STREET LEVEL WITH BELT CONVEYOR BENEATH THEM

at the discharge ends and be sucked through the shell, together with the moisture and dust from the coal, by fans at the opposite ends. These fans will discharge into cyclone dust collectors installed on the roof.

After drying, the powdered coal will be delivered to the dry-coal bunker on the roof by means of a bucket elevator. From the dry-coal bunker the coal will feed through chutes to four pulverizing mills. These will grind the dry coal to a fineness permitting 95 per cent. to pass a 100-mesh screen and 85 per cent. to pass a 200-mesh screen. The powdered coal will be carried from these mills by screw conveyor to the north side of the building, raised to the roof by bucket elevators and distributed by screw conveyors to steel bins in the boiler plant.

The powdered coal will be taken from the bottom of the steel storage bins by short screw conveyors driven by variable-speed motors and delivered into down pipes communicating with the burners. The passage of the coal through the down pipes is facilitated by air.

Dutch ovens have been constructed in front of each boiler and the floor cut away to provide the necessary furnace volume and slag pits. The clean-out doors for the slag pits are at the basement floor level under the

DRIER BEFORE PLACING BRICKWORK, WITH DRIER FURNACE IN BACKGROUND

boiler room, and slag will be handled in wheelbarrows to a bucket elevator which will raise it to the top of a concrete ash bunker. This bunker is arranged to discharge into railroad cars or auto trucks.

Further details of this installation are given in an article by G. E. Quinman in the July issue of the *Puget Sound Electric Journal.*

Government a Large Owner of Machine Tools

Last year under the stimulus of war demand the machine tool industry of the country reached a productive capacity of around $400,000,000 a year, equivalent at pre-war prices to $250,000,000. Of so-called standard lines, the annual output is placed at about $100,000,000 now, compared with $50,000,000 in 1914.

After cancellations of war contracts, about $300,000,000 worth of government-owned machine tools were turned over to the salvage committee of the War Department to be placed on the market again. Of this total approximately $200,000,000 worth are standard machine tools in new or prime condition.

As a means of disposing of this large stock of government-owned tools, it has been suggested that the machine-tool builders dispose of one government machine for each one sold from their current manufacturing stock. It will probably require about four years to clean up the government stock. It is possible that the surplus of machine tools will be used to rehabilitate the industries of Belgium and northern France. This particular subject will be investigated by Chairman Baruch of the War Industries Board and Director Replogle of the steel division while they are in Europe—*Boston News Bureau.*

The Electrical Study Course—Parallel Operation of Generators—II

Continues the discussion of the preceding lesson. Explains why shunt generators operate in parallel satisfactorily, and goes on to give the theory applying to the cutting-in and cutting-out of such machines.

IN THE preceding lesson it was shown that a study of the external characteristic curves of generators led to the conclusion that shunt generators would operate successfully in parallel and that compound ones would likewise do so, but that the conclusion in regard to the latter type was erroneous and that an extra

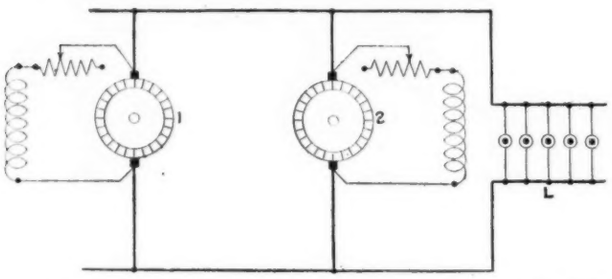


FIG. 1. TWO SHUNT-WOUND GENERATORS CONNECTED IN PARALLEL

connection, called the equalizer, had to be used to keep the loads upon them balanced. The reasons for the failure of the compound type to operate together satisfactorily without an equalizer were explained, and it was shown how the equalizer overcame the difficulty encountered.

The next subject to be investigated is why shunt generators exhibit no tendency to unbalance when connected in parallel. In reality the explanation was given in the course of the discussion on compound machines. It was found that their instability was due entirely to the influence of the series-field currents. When this was corrected by means of the equalizer, the generators worked without any hitch although no change whatever had been made in the manner of using the shunt fields, and consequently it is to be presumed that if the series fields were removed entirely, the machines would continue to run as shunt generators without any disturbance. To investigate the behavior of shunt generators in parallel, reference will be made to Fig. 1. Assume that the two generators Nos. 1 and 2 are delivering current to a load L, and that the load is equally divided between them. Suppose, now, that, due to some cause, such as a slight increase in speed, the generated voltage of generator No. 1 is augmented. The result will be to increase the current delivered by it since $I = \frac{E_g - E}{R}$, where I represents armature current, E_g generated voltage, E terminal voltage, and R armature resistance. However, an increase of current in a shunt generator tends to decrease the terminal voltage, which in turn would decrease the current. We therefore have the condition that the very increase of the current acts as a check upon itself to prevent any further growth, which is the exact reverse of what was found to be the case with compound generators.

Having found the effect upon generator No. 1, let us investigate what happens in No. 2 during the same period. Since the load upon the machines remains practically the same, the part supplied by No. 2 must decrease if anything occurs to increase that delivered by No. 1. A reduction of current in a shunt machine tends to increase its terminal voltage, which would cause an increase of current. Hence we have a condition just opposite to that found in machine No. 1: namely, that a decrease in current automatically operates to cause an increase and thereby prevents the cumulative action found in the case of compound machines. The net result of the actions in the two generators is an effort to make themselves continue to share any joint load upon them equally, once they have been adjusted for that condition, in opposition to any influence tending to unbalance the equal distribution. Of course it is understood that they must have identical external characteristic curves if they are to maintain the correct division of the load when it changes, as was explained in the previous lesson.

It is apparent from the foregoing that the satisfactory behavior of shunt generators in parallel is a result of the fact that the terminal voltage falls with increase of current and rises with decrease thereof, a condition indicated graphically by their external characteristic curves, of which *A* in Fig. 2 is a typical example. On the other hand, generators whose terminal voltage rises with increase of current—that is, overcompounded ones—refuse to operate in parallel without the use of an equalizing connection, as shown in the previous lesson. A typical example of the external characteristic of such machines is *B* of Fig. 2. The

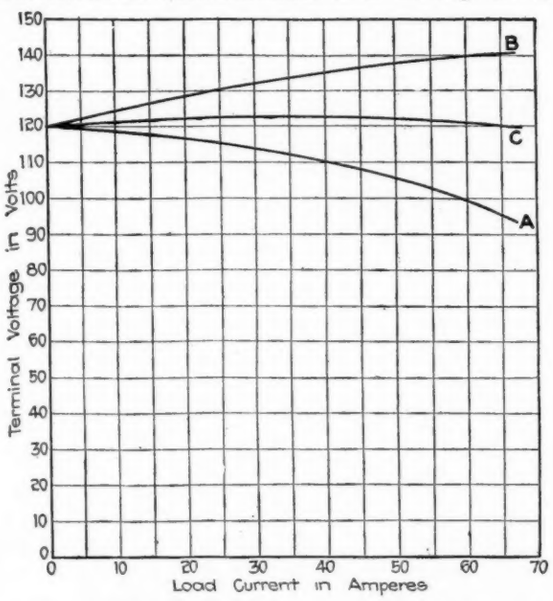


FIG. 2. DIRECT-CURRENT GENERATOR EXTERNAL CHARACTERISTIC CURVES

behavior of generators in parallel is therefore seen to depend upon the shapes of their external characteristic curves. If these are of the "rising" type, as *B*, the machines will not parallel without an equalizer, but if of the "drooping" type, as *A*, they will do so. Consequently, we find that as the steepness of the curve *B* decreases, the violence of the unbalancing previously described becomes less pronounced, until, when flat-componding, as illustrated by curve *C*, is attained, there is no serious unbalancing, and finally, when under-

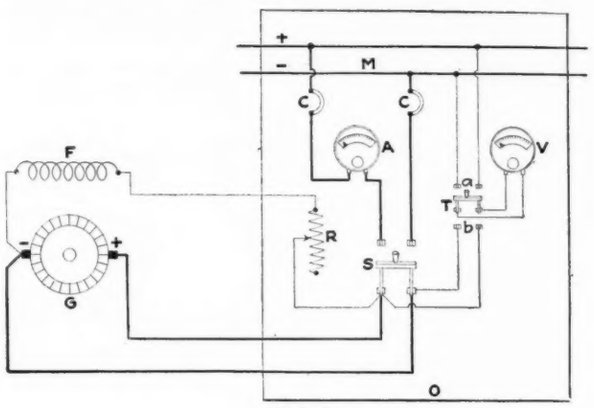


FIG. 3

compounding is reached, there is none. The ultimate step in undercompounding is the complete elimination of series-field effect, which is equivalent to straight shunt operation as in *A*, and which is, as just shown, entirely successful.

There are a number of points that require attention when cutting-in a generator to operate in parallel with others and also when cutting-out one that is so operating. In the main the procedure for shunt and compound generators is the same, but there is some difference, and the two will therefore be treated separately.

In Fig. 3 are shown the connections of a self-excited shunt generator *G* that is part of a system of other generators connected to the busbars *M*. Within the outline *O* are represented the devices on the switchboard used in controlling it. They consist of the main switch *S*, which is of course open when the machine is not in service, the field rheostat *R* for adjusting the current through the field coils *F*, a voltmeter *V* connected to a switch *T* for obtaining the voltage at the busbars *M* and the generator respectively, an ammeter *A* for measuring the current output of the machine; and circuit-breakers *CC* to protect it against overload. We will assume that while the set is at rest it becomes necessary to place it in service, and follow the steps necessary to accomplish this.

The first thing to do is to start the unit and bring it up to normal speed, after which switch *T* is thrown to position *b* and the field current is adjusted by means of the rheostat *R* until the voltmeter *V* indicates approximately normal voltage. The switch *T* is then thrown to position *a* and the reading of voltmeter *V* is noted, upon which *T* is thrown back to *b* and the voltage of the generator adjusted to exactly the same value by further manipulation of rheostat *R*. Switch *T* is then thrown from *b* to *a* and back again to assure the operator that the two voltages are of like values, and if they are not quite so the rheostat *R* is manipulated until they have been made equal. The switch *S* is then closed, thereby connecting the generator to the mains *M*. If the voltage of the generator has been carefully adjusted to the same value as that of the mains, the ammeter *A* will indicate no current.

If the voltage of the generator was a little lower than that of the mains, the ammeter will show a reversed deflection, showing that current is being taken from the mains by the machine; and if the generator voltage was somewhat greater than that of the mains, the ammeter would indicate in the correct direction and its reading would be the current delivered to the system by the machine. These conditions follow from the relation $I = \frac{E_g - E}{R}$, where I is the generator armature current, E_g the open-circuit voltage of the generator, E the voltage of the mains, and R the resistance of the generator armature. From this it is seen that when E equals E_g we have $I = \frac{O}{R} = O$, when E is greater than E_g the value of I will be negative, and that when E is less than E_g the value of I will be positive. When I is negative it means that the machine is taking current instead of delivering it; that is, it is running as a motor and E_g is really

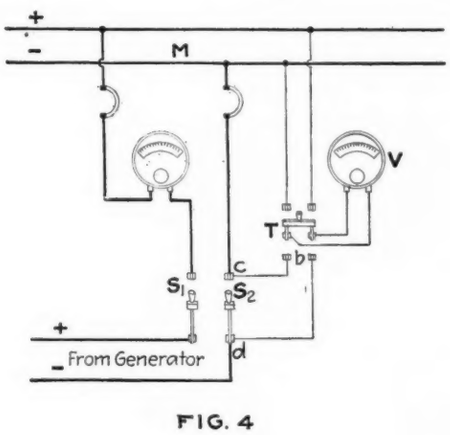


FIG. 4

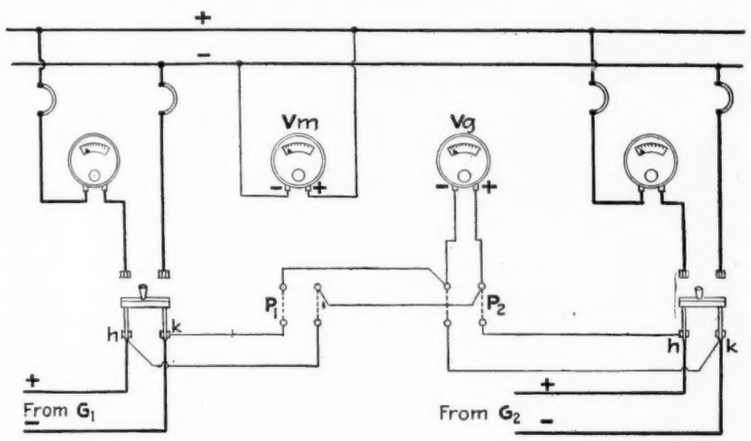


FIG. 5

FIGS. 3 TO 5. DIAGRAMS OF CONNECTIONS FOR OPERATING SHUNT-WOUND GENERATORS IN PARALLEL

the counter-em.f. Provided I is small, no disturbance will be created by the fact that the generator is running as a motor, since the direction of rotation of a shunt machine is the same irrespective of whether it is running as a motor or as a generator. When I is positive, it of course indicates that the machine is operating as a generator and delivering current to the system. Having connected the generator to the mains, it is then made to assume its share of the load by cutting out resistance in the rheostat R, thereby increasing the current through the field F, which in turn increases the magnetic field of the generator and so increases the generated voltage, thereby increasing the current. The resistance of the rheostat is reduced until the ammeter A indicates that the generator is delivering the current required of it.

When it is desired to remove a generator from the system, the resistance of the rheostat R is increased until the ammeter A reads zero current, showing that the voltage generated by the machine is exactly equal to the voltage of the mains. The switch S is then opened, disconnecting the generator, whereupon its prime mover is shut down and the unit is dead.

A slightly different arrangement of control is shown in Fig. 4. Instead of using the double-pole switch S of Fig. 3, two single-pole switches S_1 and S_2 are used, and the side b of voltmeter switch T is connected across the terminals of switch S_2 instead of as shown in Fig. 3. When it is desired to place the generator into service, it is started and switch S_1 is closed but not S_2. Switch T is thrown to position b and the field rheostat is manipulated until the voltmeter indicates zero voltage, when switch S_2 is closed. In this method it is not necessary to throw switch T from a to b and back to compare the generator and service voltages. When the voltmeter reading is reversed, it indicates that the generator voltage is too low, and conversely, when it shows a reading in the correct direction it is an indication that the voltage of the generator is too high. After switch S_2 has been thrown in, the load is adjusted in the same manner as previously described, and to remove the machine from service the procedure outlined before is likewise followed, except that there are two main switches, S_1 and S_2, to open instead of the one switch S of Fig. 3.

Often the double-pole double-throw switch T is replaced by a special plug switch. It is necessary to use a switch of that kind when a single voltmeter is installed on a switchboard that controls a number of machines. It is usual practice to install two voltmeters, as shown in Fig. 5, one of which, V_m, is connected directly to the mains and the other of which, V_g, can be connected to any one of the generators controlled from the switchboard by means of the plug switch provided for the purpose. There would be a set of switch contacts for each generator, such as P_1 and P_2 for generators G_1 and G_2 in Fig. 5, and the voltmeter circuit would be completed as indicated by the dotted lines when the plug was inserted into the contacts. There being only one plug, only one generator at a time could be connected to the voltmeter V_g, thus obviating the possibility of connecting any of the machines together through the contacts P_1 and P_2, which would cause serious consequences if the machines were not of equal voltages.

The details of paralleling compound generators will be taken up in the next lesson in the same manner as shunt generators have been treated of in the foregoing.

In the problem of the preceding lesson it was required to determine the values of the currents delivered by the generators whose external characteristics were represented in Fig. 1 of that lesson, when the total load was such as to cause the machines to deliver a terminal voltage of 110 volts. The curves are reproduced in Fig. 6, and to answer the question we follow the line corresponding to 110 volts until it crosses the curves; from the points of intersection we drop vertical lines and find at what number of amperes they cut the scale of load currents. These processes are indicated in the figure and give results of about 41.5 amperes for generator A and 22 amperes for B.

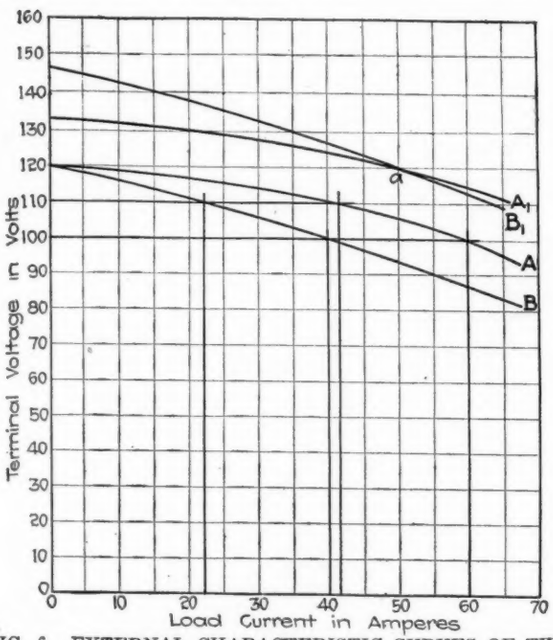


FIG. 6. EXTERNAL CHARACTERISTIC CURVES OF TWO SHUNT GENERATORS OF UNLIKE DESIGN

The second part of the problem was to show the position the curves would have to occupy in order that they should divide a load of 100 amperes at 120 volts between them equally. Since the total load is 100 amperes, each of the machines would have to deliver $\frac{100}{2} = 50$ amperes. In order that they should do so at 120 volts, their curves would have to pass through the point corresponding to 50 amperes at 120 volts, which is shown at a in Fig. 12. The curves would therefore occupy the positions of A_1 and B_1 as shown.

Two 100-kw. 230-volt shunt generators are operated in parallel. The armature resistance of each is 0.01 ohm. If the generated voltage of one was 234 volts and that of the other 233 volts, what would be the value of the current delivered to the load provided the busbar voltage is 230 volts?

Pat had got a job as a stoker on a ship, and, before starting, asked for a bucket of whitewash and brush.

"For what?" asked the chief stoker.

"Well," said Pat, "these submarines can see smoke a long way off, so I am up to them, for I always whitewash my coal before starting."

Making the CO_2 Recorder Pay Dividends

By M. A. SALLER

The CO_2 indicator or recorder does not of itself improve the efficiency of the plant, but merely shows what is being accomplished; hence, every engineer should be acquainted with the operation of the instrument, so that he may use the information it gives to aid in the economical combustion of coal.

TO SHOW the possibility for saving by more careful attention to combustion, take a set of operating conditions under which 15 per cent. of CO_2 is obtained, or practically perfect results. The loss in this case, assuming that the flue-gas temperature is 425 to 500 deg. F., is about 12 per cent., which is accepted as unpreventable because of the necessary heating of the flue gases to produce draft. However, if only a 10 per cent. CO_2 reading is obtained, the heat loss would amount to 17½ per cent., representing an excess over the unpreventable loss of over 5 per cent., while with only a 5 per cent. CO_2 reading the loss of heat in the flue gas would amount to 35 per cent., or a preventable loss of almost 25 per cent.

Causes of Low CO_2 Readings

Low CO_2 reading may be caused by excess air, insufficient air or improper mixture of air and gases. Excess air may be caused by leaks in the boiler setting, carrying too thin a fire, holes in the fire bed or too strong a draft.

Leaks permitting the infiltration of air into the setting through the brickwork or doors can be readily detected by means of the old candle method. A lighted candle is passed slowly over the brickwork and door joints, and at those places where the leakage of air into the furnace is going on the flame will be drawn or sucked in. All these places should be chalk-marked and should then receive immediate attention. The holes and cracks should be plugged and calked with asbestos twine mixed with fireclay or some of the other commercial furnace calking materials or plastic cements. After the leaks have all been stopped, the whole setting should be plastered or painted with a thin coating of plastic airproof material. Leaks are particularly troublesome where door frames or supporting beams join the setting, and these points should have frequent attention.

Detecting Air Leaks by Smoke Method

Another method of showing up air leaks is to start a brisk fire with green fuel while the dampers are open. Suddenly closing the dampers will result in confining large volumes of smoke within the setting, which will penetrate the larger cracks and crevices and show itself on the outside of the setting. This method will probably show up only the larger leaks and is not so effective as the candle method, though it is useful where a quick test is desired.

The next most important cause is the carrying of too thin a fire, which permits large quantities of air to pass through the fire and up the stack without participating in the complete scheme of combustion. This condition can be remedied either by reducing the amount of draft or by carrying a thicker fuel bed.

Importance of an Even Fuel Bed

Holes in the fire will naturally permit the infiltration of large quantities of air. This is usually due to careless or ignorant firing and the men should be instructed to carry a level and even fuel bed. Spotty fires are often caused by too frequent stirring and use of the fire tools. Where a clinker is caught in the grate and holds it open, the fire is liable to be burned through in advance of the other portions of the bed. If the clinker or ash clogs the grate and stops the passage of air, the combustion is reduced in the immediate vicinity while the inrush of air in other portions will quickly burn through the fire in spots. Even firing, with the minimum of shaking and handling, and the avoidance of clinkers will usually eliminate trouble of this nature.

It will be found sometimes that excess air is the result of using grates that contain air spaces too large for the size of fuel used, allowing the bed to fall through at some points, or else resulting in an uneven distribution of the fuel, through which thin spots the air will rush without being completely broken up.

Excess air may be caused by too strong a draft. This should be reduced or else the fire bed should be carried thicker. Often what appears to be excess draft is caused by the use of coal of uneven quality, the large lumps usually forming in such a way as to allow the air to pass too freely through that portion of the fire.

Insufficient Air or Draft Causes Low CO_2

Low CO_2 is also caused by insufficient air or too little draft. The fuel bed may be too thick or the air spaces in the grate may be clogged with clinker or slag. Again, the air spaces in the grate may be clear but may still be too small or insufficient in number to pass all the air needed for proper combustion in the fuel bed. Leaks in the setting or flues beyond the combustion chamber help to cut down the draft. Dirty or clogged boiler tubes or flues and dampers retard the draft. If the chimney or flue is overloaded or too small for the volume of gases it is called upon to handle, there will naturally be a restriction of the draft. Where draft is insufficient the use of an auxiliary blower often solves the problem.

One of the most common causes of insufficient draft is the clogging of the grates with clinker or melted ash. Portions of the fire that have been turned over when the slice bar is being used are often so stirred up that ash finds its way to the top of the burning bed and under the intense heat melts and runs down on the grate, where it cools and forms hard clinker.

Excessive fusing of the ash depends on the quality

of the coal. If the coal is high in sulphur, iron, alumina or silica, the fusing of the ash will usually be noticed.

Insufficient air follows when the fires are charged with too thick a layer of fresh fuel. When the thick cover of fresh coal is thrown on the fire, the air supply is momentarily restricted and the volatile gases driven off leave the fuel so rapidly that the supply of air is not sufficient to burn them completely. For this reason the fuel should be added in thin, even charges. In some cases it is desirable to arrange an auxiliary air inlet above the fire for admitting extra air to take care of these periods of probable shortage through the fuel bed.

Removable Truck Safety-First Switchboard Units

For use in electric-power plants the removable-truck type safety-first switchboard units shown in Figs. 1 and 2 can be obtained for the control of generators, motors and feeder circuits, and are particularly adapted to plants where electrical distribution to various buildings is made from economically located distribution centers. The construction is such that extensions to the switchboard can be made readily or the units removed to other locations to meet changed or new conditions. All live parts are inclosed, and the opportunity for an operator to come in contact with the circuit is practically eliminated. A spare removable unit can be used to reduce the time of shutdown for inspection or repairs. Busbars need not be killed, disconnecting switches need not be opened, leads and small wirings are not disturbed. The design of the unit is in accordance with the best engineering practice. The oil switches, busses and all live parts are in compartments. This tends to reduce fire hazard and limits disturbances to a single point.

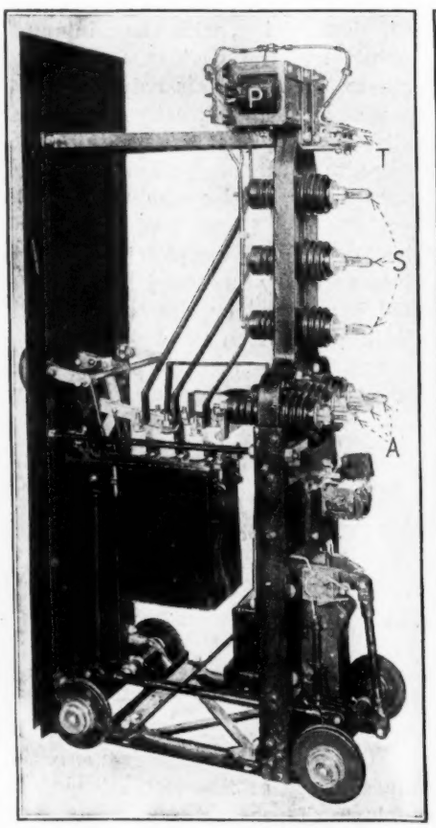


FIG. 1. REMOVABLE ELEMENT OF SWITCHBOARD

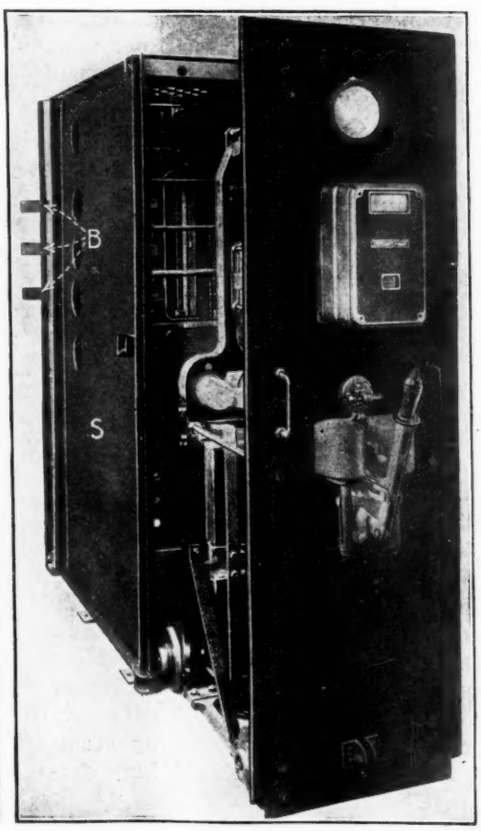


FIG. 2. SAFETY-FIRST SWITCHBOARD UNIT COMPLETE

The stationary member *S*, Fig. 2, of the removable-truck switchboard carries current and potential busses, and their disconnecting switch studs and barriers between the current studs to prevent accidental contact by anyone who enters the compartment.

The rear end of the current disconnecting-switch studs in the compartment run to busses *B* and to incoming or outgoing leads; the potential bus wires to small contact studs near the top of the compartment. The side walls of the compartments are provided with handholes, so that the busbars and bus wires can be continued from unit to unit. On the exposed wall of the end units these openings can be closed by removable covers. Access to the rear of a compartment can be had by means of hinged sheet-steel doors provided with means for padlocking in the closed position.

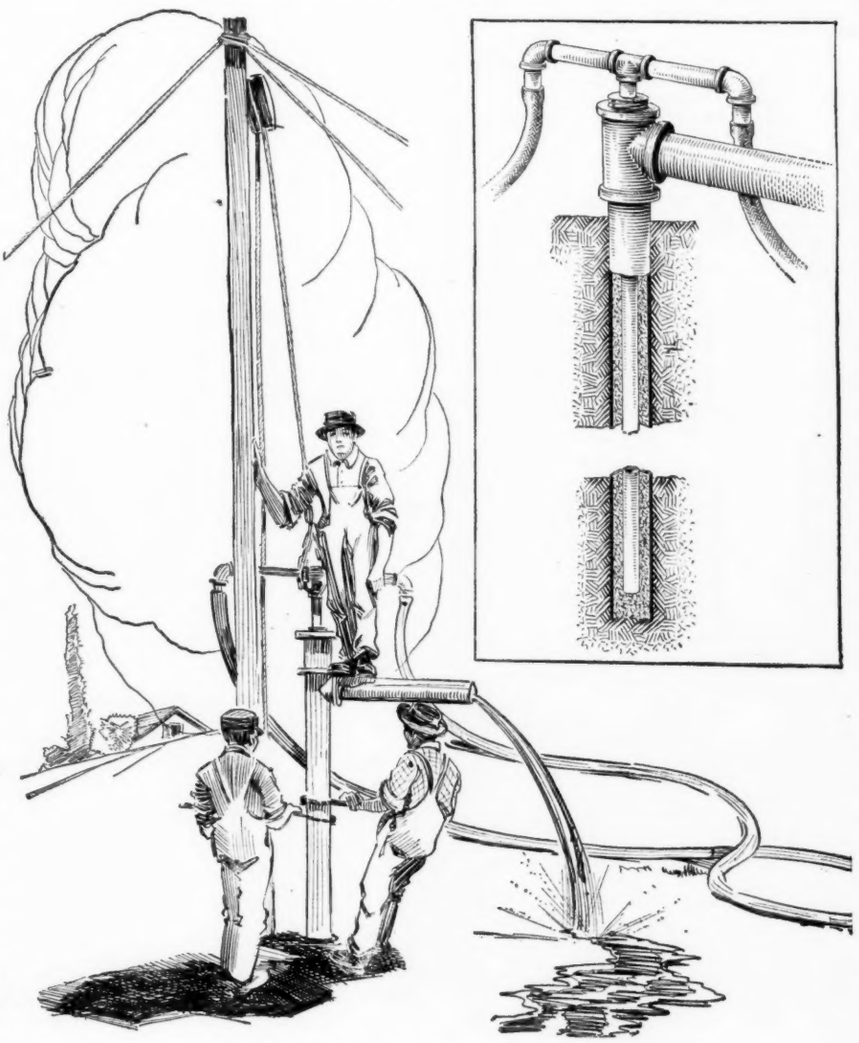
The removable truck, Fig. 1, also shown in the foreground of Fig. 2, is mounted on wheels. The fore part carries a sheet-steel panel, on which are mounted the instruments, oil switches and other appliances usually mounted on the ordinary slate switchboard panel. The current transformers, when used, are mounted on steel brackets back of the instrument panel. The rear of the truck carries the movable parts of the disconnecting switches, the potential transformers and small wire accessories. The disconnecting switch to the busbar is shown at *S*, Fig. 1, and those from the outgoing circuit at *A*. The potential transformers *P* are mounted at the top of the rear of the truck, with their leads connecting to small disconnecting switches *T*. To center the truck and to assist in placing it in or removing it from the compartment rails fastened to the side of the compartment are furnished. The oil switches, instruments, transformers and all adjunct parts are removed entirely from the installation by wheeling out the truck. To remove or replace a switch unit, the oil switch must be opened, and therefore the load disconnected. This is provided for by an interlocking attachment to the oil-switch operating toggle which engages cast lugs on the walls of the stationary unit. With the oil switch closed it is impossible to remove or insert the truck. The value of this feature needs no discussion.

The panels are manufactured in a variety of styles and capacities by the General Electric Co., of Schenectady, N. Y., varying from the smallest size up to and including 1200 amperes, and to operate at voltages up to 15,000. In the larger sizes the housings are usually of reinforced concrete, and all capacities are designed for use with either solenoid or manually operated oil circuit-breakers.

Drilling a Well by Hydraulic Pressure

By W. S. Heckendorn

Our experience in drilling a well with hydraulic pressure may be of interest to others. We first obtained an 18-in. well-drilling outfit and put down a test hole, in which we found fine sand and water at a depth of 6 ft. Then we connected a 3-in. centrifugal pump to the well and ran it for an hour without lowering the water. From the indications there was plenty of water, and we began to look for someone to put in a 12-ft. well down to coarse gravel, but the lowest bid was $1200. I advocated putting in points if we could get them, although it would require quite a number for a 165-gal. per minute pump. We finally got a price of $300 on 12 points. A 5-in. pipe was obtained for a casing, also a 5-in. tee. The pipe was cut so as to put a coupling 12 ft. from the tee. The tee was attached to the casing with the side outlet horizontal, and the top outlet was reduced from 5 in. to 2 in. A long thread was cut on a 12-ft. piece of 2-in. pipe so as to screw through the bushing from the under side. A tee was then screwed to the top end of the 2-in. pipe with a close nipple on each side, to which was screwed an ell and a nipple turned down for connecting two lines of 2-in. hose from the pump.



RIG FOR SINKING WELLS AND HOW IT WAS APPLIED

When all was ready, we ran two lines of 2-in. pipe from the pump to the derrick and attached the hose. A man was stationed on top of the discharge pipe from the side outlet of the 5-in. tee that was used to carry the water away from the well, and two pairs of chain tongs were used to turn the pipe from right to left and back, so as to give a cutting action in the ground. The idea is shown in the illustration. Then, dressed in a rubber suit to keep dry, the operator started the water. At first the water refused to run through the pipe, and the latter was lifted and the end cleaned out and then let down easily. When the water was turned on the pipe sank into soft black dirt at a rate of about a foot at a time. When sand was reached, we stopped to add another 12-ft. section of pipe. This was done by removing the 4-ft. length of discharge pipe and the hose, and the tee head was then unscrewed from the 5-in. pipe, and it, with the 2-in. length of pipe, was taken out, after which another 12-ft. length was added to both the 5- and the 2-in. pipe, and all was screwed together again. With this arrangement the stream of water from the hose washed out sand and gravel as fast as the pipes could drop to the hard ground, which was from 12 to 23 ft. below the surface. Some of the stones thrown out weighed as much as 7 oz. each. We put in eleven 4-in. by 6-ft. well points with sawed openings at each end for very fine sand and larger openings for coarse gravel in the 3-ft. length above the center of the points. They furnish all the water that a 165-gal. pump can handle. The pipe line is placed in a trench to within 18 in. of the water direct from the pump, with the crosses 6 ft. apart and the points 4 ft. from the line on each side, making them 8 ft. apart. The water is clear and cold all the year round, and tests 98 per cent. pure, although the city water, taken from the river, tests only 75 per cent. pure.

When the well had been drilled as far as was desired,

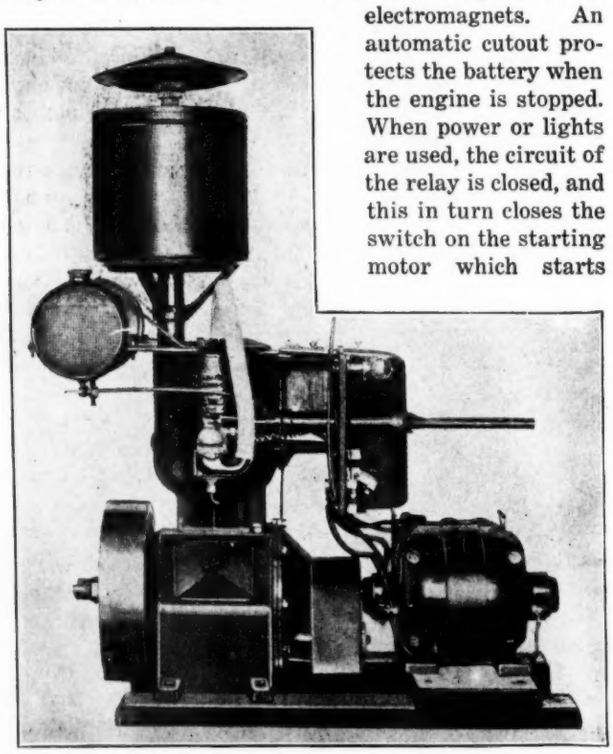
we stripped the inside piping and uncoupled the 5-in. tee, measured the whole length inside with a ¾-in. pipe and deducted the difference from the top of the casing to the right height of the pipe leading out from the cross connecting the strainer to the iron pipe, and then cut a thread for an ell. We next lowered the whole into the casing, then pulled the casing, leaving the strainer in the gravel, which we connected up with a flange fitting.

"Alco" Power and Lighting Plant

There are many places in which a small gas-engine-driven power and lighting unit can be used to advantage where steam is not available; such as for lighting buildings at a distance of, say, 1000 or 2000 ft. from the power plant, for small shops and for country and farm use. Such a power unit, known as the "Alco," is built by the Automatic Light Co., Inc., Minneapolis, Minn., and is illustrated herewith.

A single-cylinder four-cycle water-cooled engine is directly connected to a direct-current generator. The generator is duplex wound, having 110 volts on the power and lighting winding, and 7½ volts on the other, which is used as a motor for a 6-volt battery for starting the plant. When the engine is nearly up to speed, the 110-volt winding supplies current for light and power and the low-voltage winding acts as a generator and charges the starting battery.

Upon a switchboard is mounted a relay and two electromagnets. An automatic cutout protects the battery when the engine is stopped. When power or lights are used, the circuit of the relay is closed, and this in turn closes the switch on the starting motor which starts

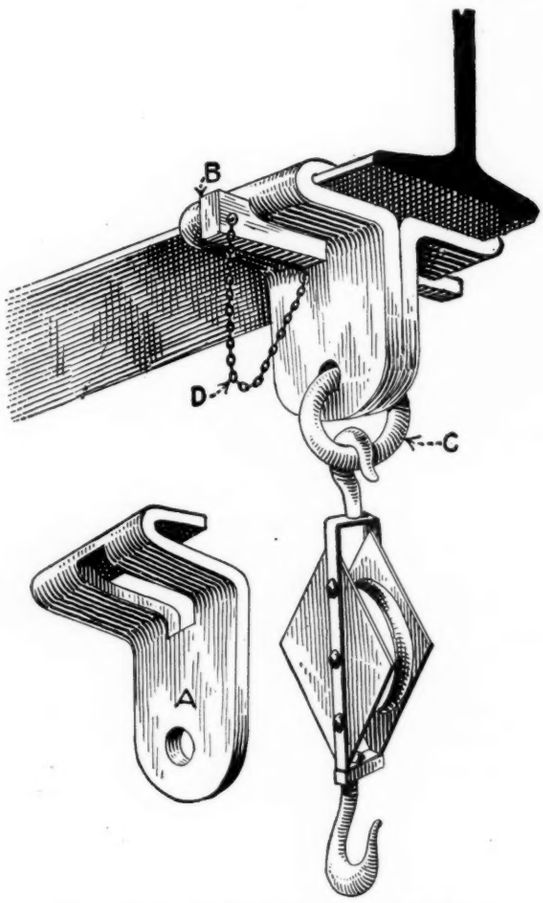


COMPLETE POWER AND LIGHTING PLANT

the engine. When 90 volts are reached, the 6-volt current cuts out, and the 110-volt cuts in. The operation reverses when the last light or power motor is turned off, and the plant then stops. Voltage regulation is accomplished by an electric solenoid governor that acts directly on the throttle of the carburetor, opening and closing it to take care of the slightest variation in voltage.

Quickly Detachable Clamp

A quickly removable clamp which can be used anywhere about the place where I-beams are used is shown in the illustration, taken from *Coal Age*. The clamp is made of two sections of machine steel *A*, each being slotted to receive the taper key *B*. In operating the sections *A* are clamped tightly against the lower part of the beam by means of the wedge. The hanging ring



DETAILS OF EASILY DETACHABLE CLAMP

is welded after passing through the lower holes of the sections. The holes should be large enough to allow free motion of the ring in order to permit setting and removing the hangers from the beam. For the sake of keeping all parts together, the key may be fastened to one of the sections by means of a small metal chain, *D*, as shown.

After all, what caused the war, or at least created conditions making it necessary for Germany to do something desperate, if it was not her vaunted foreign-trade policy of subsidies, credits, etc.? Any policy or transaction that is not in itself mutually profitable or beneficial to buyer and seller is bound to end disastrously if persisted in, and the more extensive the scale the greater will be the disaster. Germany for years had been guilty of "crooked" dealing and attempted to maintain her false position by a grand military campaign to ward off the inevitable commercial catastrophe. "Dumping," or selling goods below cost, cannot be carried on profitably, subsidies notwithstanding.

EDITORIALS

Metering the Air Supply to the Furnace

FROM the point of view of the fireman it is unfortunate that atmospheric air is invisible and so difficult to measure or to weigh accurately. It takes an active imagination to make a mental picture of air sweeping up into the furnace through the fuel bed, slyly slipping past the openings in the fire-door or sneaking stealthily through random chinks and porous brickwork.

Think of the simplicity of the problem of combustion if air could be as easily seen and handled as sawdust, and as readily weighed and measured! There would be no trouble at all in furnishing just the exact amount needed to burn each pound of coal to the best advantage, and if some of it tried to get inside the boiler setting in any way except through the approved channels, anyone but a blind man would be able to detect it.

But, as a former President once remarked, "It is a condition and not a theory that confronts us." Air must be recognized by its effects and not by its color or form or weight. No satisfactory method, applicable to the average boiler plant, has been devised whereby a definite quantity of air, by volume or by weight, can be metered on its way into the furnace. But though it is such a tricky, elusive gas before it combines with the fuel, it becomes fairly tractable and meek after it has been changed into carbon monoxide and carbon dioxide; for then it can be captured, put through the third degree and forced to reveal the information that is needed.

All this is accomplished by means of the flue-gas analyzer. That very useful instrument will take a gas sample and split it up, showing just what percentages of CO_2, O and CO it contains; and from such data it is possible to tell just how much air per pound of fuel has been admitted to the boiler setting. If the amount is excessive, that fact is at once apparent and the remedy can be applied.

Of course this method makes it necessary for the fireman to know how to handle the analyzer and interpret its readings; but that is a simple task as compared with the difficulty of trying to measure the air in pounds or cubic feet. And as the analyzer is destined to become more and more popular as a part of the equipment in the boiler room, firemen who neglect or refuse to learn the how and why of its action are blind to their own best interests.

It is not feasible to approach the air-supply problem from the front of the boiler, but it yields to an attack from the rear. It is practically impossible to measure air accurately and determine how much is going into the furnace; but after it has entered there is little difficulty in determining the quantity and the kind of associations it has formed and from them deducing the original amount of air that must have been admitted. This may seem like a roundabout way of getting the information, but it is the best that has yet been suggested and it produces the desired results.

More than once we have been called upon to calculate the weight of air required for the complete combustion of coal of a given composition, in order to satisfy some engineer or fireman who has been wrestling with the problem of burning coal economically. That information is readily obtainable; but we have always harbored a certain degree of curiosity as to what practical use was made of the figures thus furnished to the inquirer, and we have felt the temptation to ask him, in the language of a certain well-known cartoonist, "Now that you've got it, what are you gonna do with it?"

The Wage Problem

CONSIDERABLE newspaper criticism has appeared regarding Henry Ford, especially since his campaign for the United States Senate, and most of his motives and actions have been imputed to self-advertising. One item insists that this is so regarding the increase from five to six dollars a day in the wages of employees in his shops, to say nothing of his retirement from the presidency of the company in favor of his son Edsel, with a salary of one hundred and fifty thousand dollars a year. The item goes on to say that "only the Ford plant can afford to pay workers a uniform wage of six dollars a day."

Most men are misjudged when others reap some benefit from their actions, and it is difficult for the average business man to understand that there is reason or justice in paying men a wage of six dollars per day when their places can be filled with cheaper labor. The Ford plant is not the only one that can afford to pay a uniform wage of six dollars a day, although it may be the only one that realizes that the laborer is worthy of his hire. The average business man has not come to that way of thinking as yet, but the workingman has.

Wages and working hours are two great problems that will confront business in the future, and both will have to be recognized and satisfactorily settled. The recent strike of marine workmen in New York harbor may be cited. These men demand an eight-hour day and a twenty-five per cent. wage increase. After waiting for months for a settlement of their demands, they struck, and a complete suspension of river and harbor traffic was the result.

That the boat owners believe their men have been treated fairly is evidenced by the statement by one who spoke of a man who had been in his employ for a long period: "Why, we have taken care of Mr. Blank for about twenty years, and he has saved one thousand dollars." In other words, because Mr. Blank has worked for this boat owner twenty years he has been taken care of, and because he has been able to scrape together one thousand dollars, he has been receiving fair wages. If Mr. Blank had not been "taken care of" for the past twenty years, he might now be chief engineer of an ocean steamer, receiving a good salary.

The question of wages is here to stay. During the war workmen were able to command higher wages than had ever been paid before in this or any other country. Power-plant engineers have, of course, been benefited by a greater or less increase in pay, but not commensurate with what has been received by munition workers, carpenters and other trades, nor in proportion to the rise in the cost of the necessities of life.

The employer and employee must arrive at a wage basis before a satisfactory settlement can be had. The employer must recognize the fact that low wages are a thing of the past and that his employees are entitled not only to enough to live on but enough to live on in comfort and with something to put by for a "rainy day." On the other hand, the employee must realize that he is in justice bound to give one hundred cents' worth of labor for each dollar received in wages. When both parties get to the point where each recognizes that the other is entitled to fair and honest dealings, the problem of wages will be largely settled.

Doubtless the realization of this condition will be slow. But the fact remains that if a man is worth five or six dollars a day to the employer he should get it, and the employee should realize that if he is getting that amount he should make an equivalent return in labor.

With the war over and marine transportation getting back to normal, one wonders how many of those ten million rounds of ammunition the Mexicans want us to release to them will be used to shoot up the oil wells whose product American consumers are willing to pay well for.

Including in the cost of production or operation the interest on the total investment whether in use or not is unfair to the business and those carrying it on, both management and employees, as it always includes a lot of "bonehead" expenditures that have no legitimate place on the books as assets. If a plant has been poorly designed, the equipment ill chosen or some personal fad has caused abnormal expenditure, it should be charged off the books or the engineer should not be accused of incompetence if he fails to make a satisfactory showing. Idle machinery is idle money and should not be expected to produce revenue. There is also a withholding of money or investment that is not only unprofitable in itself, but keeps the capital already invested from being more profitable. A thoroughly well balanced plant, exactly suited to the purpose for which it is to be used, not too elaborate in its appointments or too scantily equipped, is indeed a rarity.

Electricity

The wish has often been expressed for a paper which would be to the practical electrician what "Power" has been to the operating engineer.

"Power" has made its success by telling the story of the power plant in everyday language that could be read and understood by the busy practical man who knows more about mechanics than he does about mathematics.

The power-plant engineer has become to a greater or less extent a practical electrician. "Power" is going to tell the story of electricity to him in the same practical, helpful, easily understandable way that it has talked steam engineering to the steam engineer; and practical electricians will find in it the paper which they have been needing.

Look at the electrical pages in this number. And there are just as many articles of other kinds as before. The number of reading pages has been increased to accommodate the greater amount of electrical matter.

If it is not just what you would ask for if you were writing the specifications, let us know how it can be made to suit you better.

A few months ago thousands of men left their jobs to fight for their flag and ours. Most companies put out service flags with a star for each man who left their employ to enter the service. Now when the men are coming back, how about their jobs? Do they get them, or will they have to walk the streets looking for others? At the least, a star should be removed from the service flag for each man who does not get his job back, as an employer has no right to display them and the men will not thank him for so doing.

Just what volume of air and what strength of draft must be used to burn any particular fuel in any given furnace can be determined only by actual trial and, being once determined, should be maintained as long as the particular fuel is used. Unfortunately, there are many engineers who pay no attention to the matter of draft and fuel, but are contented to maintain steam at the required pressure, regardless of how much draft is used or how much fuel is consumed in so doing.

One of our friends who is chief engineer for a large public-utility corporation was explaining to the company's chief counsel some of the principal things about certain engineering practice in power plants. "But," interrupted the counsel, "I cannot remember all that. Won't you get me a little book on engineering that will tell all about it?" "Certainly—on one condition," said the engineer; "that you get me one telling all about the law." Now there are some engineers just like that lawyer.

When boiler-feed water is heated by exhaust steam, a saving is made of about one per cent. of fuel for each eleven degrees Fahrenheit rise in the temperature of the feed water. One would not suppose that this is really known, judging from the volume of steam escaping from exhaust heads, and feed water going to the boiler at around one hundred and eighty degrees. A larger heater in such instances would be a money-saving investment.

With the passing of the emergency created by the war situation, water-power legislation in Congress should not be shelved; the need of hydro-electric development is little less than during the active period of the war.

Being in love with your work, outside of the mere matter of making it produce your daily bread, marks the difference between a weary grind and a fine job.

CORRESPONDENCE

Trouble with Belt Tighteners

We wish to thank you for publishing our belt-tightener problems in *Power* and to say that we have overcome the difficulty by turning off the crown of the pulleys. Using the straight-faced pulleys, which we now have, makes the belt run true.

Belt manufacturers also told us that part of the trouble was due to light belting. The wide belting is 48 in. wide and $\frac{3}{8}$ in. thick, and the manufacturers think the belt stretches unevenly, making it run off, but as stated, since we have used straight-faced pulleys the trouble has disappeared. J. S. ECKERT,

Blissfield, Mich. Continental Sugar Co.

Pump Valves Do Not Wear Well

In reply to Mr. Larsen in the issue of Jan. 7, page 30, I would suggest that the temperature of the heating returns varying from 60 to 180 deg. is the chief cause of the rubber valves warping and breaking. Rubber valves will not stand such variation in temperature and if Mr. Larsen will have the valve seats ground down or faced and will put in a set of brass valves, the cost will be more but it will surely pay in the end; that is, provided the other parts of the pump are kept in good condition. PATRICK MOLLOY.

New York City, N. Y.

Boiler Horsepower from Metered Condensation

The first question answered on page 965 in the issue of Dec. 31 may be good engineering and strictly correct, but it is not what we find in actual practice or what would appeal to the average operator. Manufacturers of condensation meters are continually brought up against this question, and steam is not sold on the B.t.u. basis except in rare instances (we have never had one) as there are too many factors that may be in dispute. [The writer of the inquiry asked to have the horsepower figured and that it be based on the B.t.u.—Editor.]

The question generally is brought up as to whether they should use 30 lb. or 34½ lb. of water as the basic horsepower unit, and this is generally settled on the basis of the temperature of the returns and the actual boiler conditions as to feed-water heaters, and sufficient waste exhaust steam to produce the highest feed-water temperature at atmospheric pressure, with the result that 33 lb. is frequently called a boiler horsepower and agreed to as an arbitrary figure. Under usual conditions we would figure the boiler horsepower given in the question as follows: $1240 \times 8\frac{1}{3} \div 34.5 = 299.5$ boiler horsepower-hours, the weight of the water being considered as 8⅓ lb. per gal., owing to heat losses in returns and for which the steam producer is not willing to extend credit. We find few installations where measurement in gallons will be accepted [In this case the meter read gallons.—Editor], the approved form of meter dial registering in pounds and eliminating the heat factor. In order to get a reasonable value from the steam purchased, we recommend that a separator of ample size be installed to take out entrained water just before delivering to the consumer's premises and that piping, up to consumer's first take-off, be pitched back to this separator, which, combined with well-insulated steam lines, will eliminate losses to a considerable extent.

New York City. THEODORE HAIGHT.

[We are always glad to publish discussion letters giving various views on engineering subjects. The foregoing, however, deals with a matter that has been considered established ever since the Centennial Exposition in 1876, when the standard boiler horsepower rating was fixed as equivalent to the evaporation of 34.5 lb. of water from a feed temperature of 212 deg. F. to steam at atmospheric pressure, or an equivalent such as evaporating 30 lb. of water from a feed temperature of 100 deg. F. to steam at 70 lb. gage pressure. Tables of factors of evaporation have been worked out for a wide range of conditions of temperature and pressure, all based on the B.t.u. transmitted to the fluid as: $970.4 \times 34.5 = 33{,}478.8$ B.t.u. = one so-called boiler horsepower. It is best, however, to avoid the term horsepower, except as a generality, as an expression of boiler capacity or output, since the output of a boiler is heat energy that may or may not be converted into power, dependent on the use to which it is put.—Editor]

Saving by Lower Trap Discharge Temperature

In a plant in which there were several indirect heaters of seven sections each, two of the sections were arranged to be supplied with live steam, four with exhaust steam from the main engines, etc., and there was also a cross-connection by means of which live or exhaust steam could be supplied to the entire six sections, but the seventh section was supplied with exhaust steam from the engine driving the fan. The fan engine was discarded and a motor installed, and this seventh section was left "dead." To enable the heater to deliver enough heat when no exhaust steam was available, more steam at boiler pressure was used, but still confining it to the live-steam sections. At 100 lb. pressure the condensate left the trap at about 338 degrees F. and was lost.

A change was made by which live steam was admitted to all sections, the greater heating surface permitting it to be used at about atmospheric pressure. The condensate was discharged at about 212 deg., indicating a saving of about 126 heat units per pound of water. R. MCLAREN.

Toronto, Ont., Canada.

Generator Heats Excessively

A 125-volt 160-ampere direct-current generator in our plant heats excessively when loaded to only 90 amperes after a two hours' run, and the voltage drops. Is it possible that high-resistance brushes are the cause of the trouble? The brushes do not heat excessively.

I would like to hear an expression of opinion from *Power* readers as to the cause of this heating.

Gladstone, Mich. PETER BURKARD.

Motor Suddenly Reversed

In the electroplating department of our plant there is a 3-hp. 110-volt 2200 to 2800 r.p.m. direct-current shunt-wound motor without interpoles, driving a buffer. One morning after the motor had been running at full speed for about ten or fifteen minutes it suddenly stopped, reversed and ran in the opposite direction. A similar thing happened about two years ago. After shutting the motor down and making an inspection, the machine appeared to be in good condition and when again started operated without any further trouble.

I would like to know if any of the *Power* readers have had similar experiences, and to have an explanation as to what caused the motor to act as it did.

Pittsburgh, Penn. JOHN R. STEESKA.

Boiler Settings for Multiple-Retort Underfeed Stokers

It has just been called to my attention that Mr. Bromley in illustrating his article on "Boiler Settings for Multiple-Retort Underfeed Stokers" in the July 23, 1918, issue of *Power* used the form of setting which was designed by Vielé, Blackwell & Buck for the 1232-hp. marine type Babcock & Wilcox boilers at the new plant of the Appalachian Power Co., at Glen Lyn, Va. Although Mr. Bromley did not acknowledge the responsibility for this design, he was good enough to state that the design illustrated the most recent practice in boiler settings for underfeed stokers. In connection with this it might be interesting to call further attention to some of the features of the design which are considered to be some advance on prevailing methods. The illustration is from Mr. Bromley's article. The boiler proper is set quite a little higher than has been common practice. The stoker was moved back toward the bridge-wall several inches so that the inside line of the front furnace wall would be plumb. The bridge-wall also was made massive and as closely as possible a straight batter from bottom to top. A desirable improvement, we also believe, was the carrying of a double row of bonding tile at mid-height of the furnace walls around both the side and front. This design was worked out after consultation with the representatives of the Babcock & Wilcox Co. and the Westinghouse Electric and Manufacturing Co. and the examination of several similar settings which had developed weaknesses.

The installation of duplicate continuous spiral conveyors over the hoppers distributing coal from a bunker outside at the end of the building and in this way avoiding the usual overhead bunker, is a feature of the design.

VIELÉ, BLACKWELL & BUCK,
Consulting Engineers,
New York City. BY E. L. BROOME.

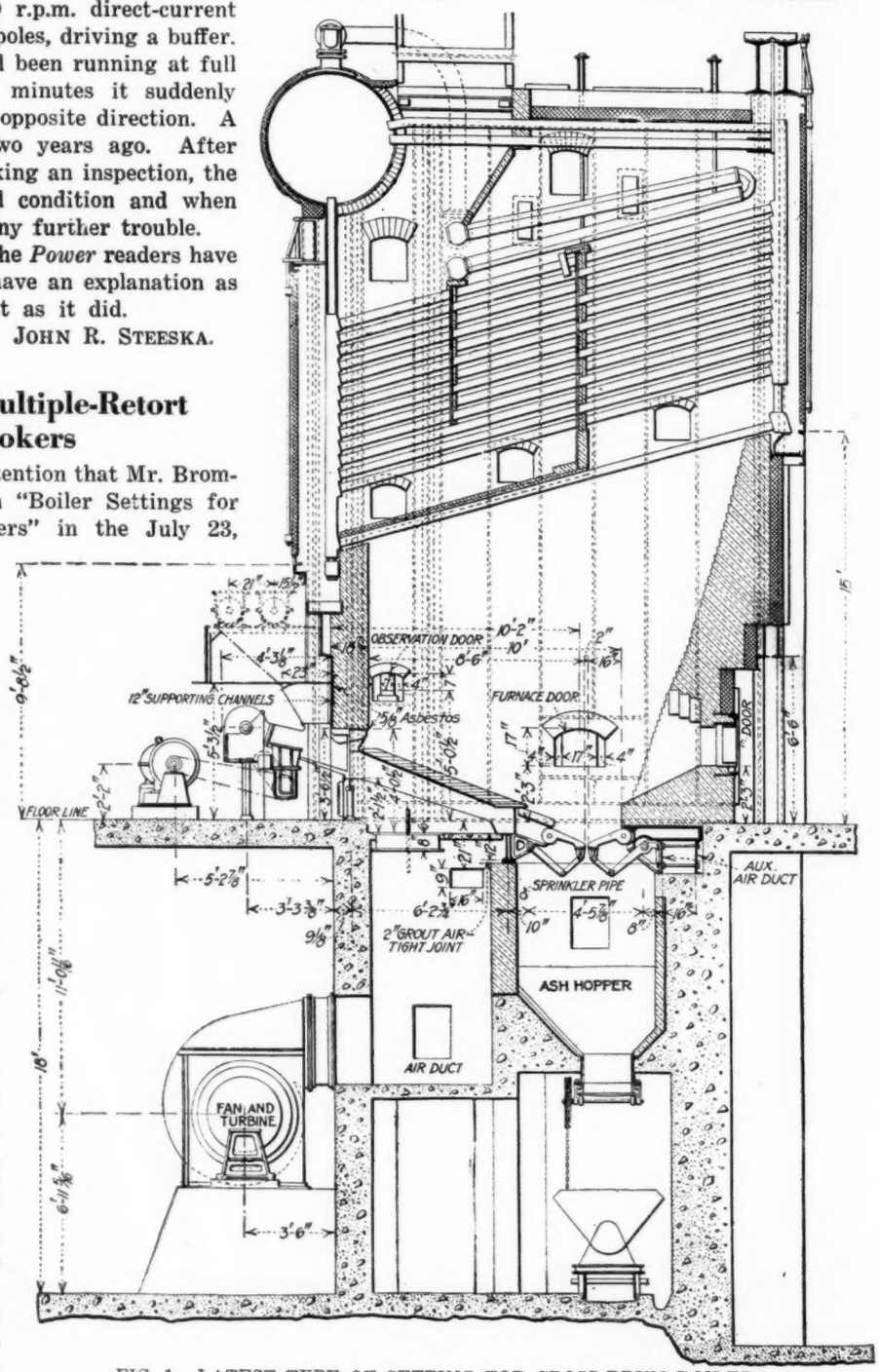


FIG. 1. LATEST TYPE OF SETTING FOR CROSS-DRUM BOILER

Observations of a Fuel Administration Inspector

I accepted the position of fuel administration inspector with some misgivings, as I had enough work of my own to do without bothering with other plants, but I am now glad that I did accept, because the knowledge gained was well worth the effort.

About the first plant that I visited was that of a large institution. The engine room was neat and the engines were running noiselessly. I first looked at the feed-water heater, the thermometer of which indicated a feed-water temperature of 210 deg., but when I put my hand on the feed pipe I found a considerable reduction in temperature. Upon looking the piping over to learn the cause, I discovered a ¾-in. water pipe with the valve full open and cold water going into the feed-pump suction pipe. The engineer said that he had to feed cold water so as to prevent the pump from getting steambound. I suggested changing the condition so that the pump would not get steambound, either by raising the heater (there was plenty of room) or by lowering the pump.

The engineer was of the opinion that open heaters were "no good," claiming that he never had seen one that did not give trouble. He said that he could not keep packing or valves in the pump for any length of time. I invited him to come to my plant where he would see a pump handling water at 214 deg. temperature, in which the piston packing and valves had not been touched for nearly a year, and cold-water injection is not used at that. Packing and valve troubles are largely caused by the changes of temperature to which they are subjected.

In the ice-machine room I noticed steam coming out of a well in one corner, and the engineer in answer to my inquiry said that it came from the generator steam trap. When I asked him why he did not return it to the feed-water heater, he replied that it was too long a run of pipe. He said that the generator operated at 11 lb., the steam being supplied through a reducing valve. I then asked why he did not use the exhaust steam from these pumps, and he replied there was no grease extractor or back-pressure valve. As a consequence the exhaust went to the roof.

Going into the boiler room I found 12 boilers in operation; a mixture of soft coal and No. 3 buckwheat was being used in the furnace. Opening the fire-door, I saw that the fire was about 18 in. thick and burning poorly. I called the engineer's attention to the condition, and he replied that he did not push them much on "days like this."

To regulate the feed pump the firemen had to go out in the cold and walk about 25 ft. to the pumproom. One can imagine the kind of regulation the pump got under the circumstances.

The soft coal was not broken up finely enough to mix intimately with the No. 3 buckwheat, and as the large lumps when thrown into the furnace lay there and did not burn evenly, the fuel bed was full of holes that required frequent raking to keep even. I will warrant that the plant was losing money instead of saving it burning that fuel under those conditions.

Brooklyn, N. Y. W. F. REMLIW.

Switching Lighting Load from Two-Wire to Three-Wire Supply

A flour mill several blocks away from our power lines desired breakdown electrical service for use when the mill was shut down or at other times when the lighting generator might be out of order. The lighting system in the mill was two-wire 110-volt.

At first it was proposed to install a transformer near the plant, because the mill was a considerable distance from the nearest secondary line; also, the load would heavily unbalance the three-wire secondary system, as well as necessitate running heavier wires than if the high voltage was used. As the service would be required only a few times each month, a primary pole-top switch was to be installed so that by disconnecting it when not in use the transformer losses could be eliminated. It was finally decided to bring in the 110-220-volt three-wire secondary line from the street and change the wiring in the mill from two-wire to three-wire by running an extra feed wire from the switchboard to the different distributing boxes and distributing the load equally on each side of the three-wire feeder. A three-pole double-throw switch was installed, as shown in the figure, and the three-wire 110-220-volt service was connected from the city secondaries as indicated. When the switch is thrown to the street service a three-wire 110-220-volt system is obtained, and when thrown to the plant generator the three-wire system is cut over to a three-wire 110-volt distribution. As will be seen, the voltage is 110 from each outside to the center conductor, but zero volts between the two outside conductors when the switch is thrown to the generator.

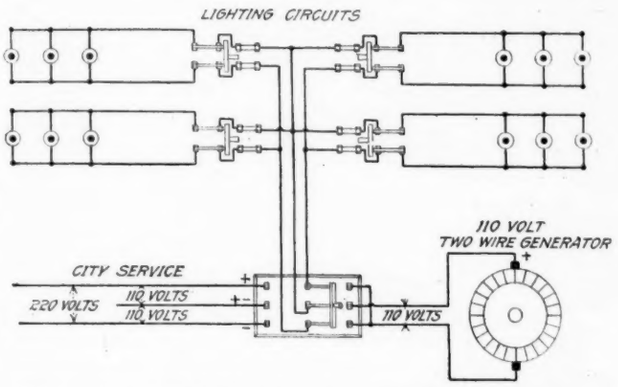


DIAGRAM OF CONNECTIONS FOR CHANGING FROM TWO-WIRE TO THREE-WIRE SERVICE

There are no doubt many installations where this method could be used to advantage, saving the cost of a transformer installation and possibly primary line extensions as well. G. M. HARDY.

Fort Monroe, Va.

Should Boilermakers Be Licensed?

On page 893 in the issue of Dec. 17, 1918, there appears an interesting letter by Mr. Sawyer, the opening paragraph of which states that in many localities plumbers are compelled to undergo examination and secure licenses and that the same rule should apply to boilermakers. Any boiler inspector of extensive experience can recall numerous instances of poor boiler repairs. In

the country as a whole, nearly all insurable boilers are insured, and it is gratifying to note that there is a growing disposition among boiler men doing repair work to insist that an inspector precede or accompany the repair man on a job. This is to the interest of the owner of the boiler in that it often guards against unnecessary mutilation of the boiler, and to the boilermaker it insures against later adverse criticism of his work when the inspector sees it. Boiler inspectors are not "infallible," but they have not only their own judgment and experience to guide their decisions, but also the records of their companies and the advice of superiors.

The first step to be taken when repairs are needed, is to call for an inspector, and any reliable boiler insurance company is glad to answer such calls for special service. It seems hardly practicable to require boilermakers to secure licenses before being permitted to do repair work. The technical side of boilermaking is an extensive study in itself; therefore, to compel the boilermaker to master all the intricate technical details of the subject would seem to be quite too rigid a requirement. A short and effective way out of it would be to require that no repairs be permitted without investigation by a qualified state, municipal or insurance inspector. As an example, the best boiler repair man I have met is a man who can barely write his name—the simplest computation would defeat him—yet he has had many years' experience as a repair man and has made good use of his opportunity to observe cause and effect. He has carefully taken advantage of every opportunity to absorb practical ideas from all with whom he has come in contact; moreover, he refuses to touch a job on an insured boiler until the inspector has seen it. As a consequence he has a good reputation over a large part of four states and his services are in great demand.

There are many cases of "boiler mutilation" called necessary repairs, most of which are due to the penny-wise and pound-foolish ideas of the boiler owner, whose whole desire is to accept the lowest bid. The ability to answer technical questions would be no guarantee, but there can be no doubt that boiler work would be vastly improved provided none but licensed men worked at the job. Boilers would undoubtedly be made safer and some of the unnecessary repairs would be avoided, but the easiest and best way to secure maximum safety is to call in the inspector and abide by his decision.

Atlanta, Ga. C. S. REGAN.

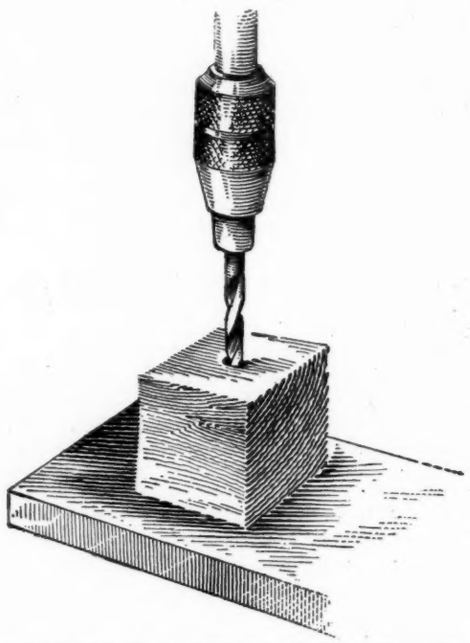
One will find poor workmen in all branches and trades, but that should not condemn all of them. If the engineers on the jobs referred to by Mr. Sawyer were licensed and let a boilermaker go ahead and do such repair jobs, then what good does licensing a trade do? An engineer certainly ought to know that a boiler with a lap crack on the longitudinal seam should be condemned at once and not let the boilermaker attempt to repair it. I have seen a 1½-in. pop safety valve connected to a boiler with a 1-in. nipple between, and the job was done by a licensed engineer. Unsafe repairs are sometimes made by engineers when in a hurry, that have nothing on the unlicensed boilermaker's worst.

I am not in favor of licensing boilermakers. Not that I think licensing them would do any harm, but because the work would not be any better than it has been in some cases where engineers are licensed. I certainly believe in good repairs and better workmanship, but I think unsafe and improper repairs would be fewer if engineers would use good judgment.

Olean, N. Y. CHARLES W. CARTER, JR.

Using a Small Twist Drill

When drilling a hard surface and using a fine drill, there is danger of breaking the drill, especially if it is high-speed and "wabbly" like a portable electric or air drill. To prevent breaking, take a small block of wood as thick as the length of the drill will allow and bore a



GUIDE BLOCK TO STEADY DELICATE DRILL

hole through it the size of the drill or a little larger and place this over the drill. There is much less chance of buckling and breaking. WILLIAM H. WATSON.

Norristown, Penn.

Determining Polarity of an Electric Circuit

When it is necessary to find the polarity of any part of a circuit, the following method is simple and the means generally at hand, since most electrical men carry a blueprint of one kind or another in their pockets:

Wet a small portion of the print and hold the two ends of the wires about 0.25 in. apart on the wetted surface. The negative will show a decided white mark. It is advisable to take the current through a lamp in order to prevent a short-circuit, although I have often made the test without its use by separating the two ends of the wires by means of a piece of wood, then taping them securely together before turning on the current. H. WILSON.

Toronto, Canada.

Steam is generally used as a source of power for drilling oil wells, but pumping is usually done by gas or gasoline engines.

INQUIRIES OF GENERAL INTEREST

Removing Lime Scale from Injector—How may an injector be cleaned when it becomes clogged with lime scale? T. E.

The scale can be removed by soaking the injector in dilute muriatic acid, using about one part of acid to ten parts of water. If the injector cannot be cleaned in this manner sufficiently to make it operative, it will be necessary to take it apart and cleanse the parts separately.

Measuring Lead Opening—What is the best method of measuring the amount of lead of a slide valve? J. L.

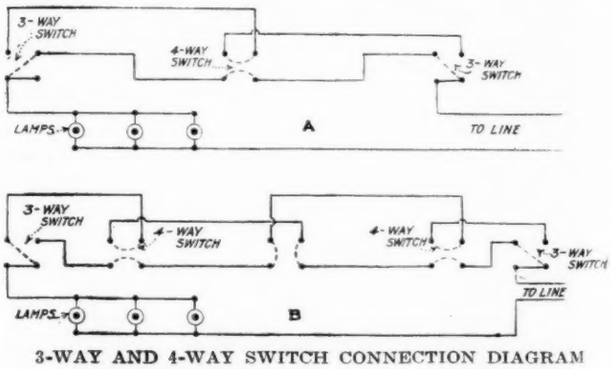
Place the engine on a center. The lead is most easily measured by pushing a wedge-shaped piece of soft wood in the valve opening. The edges of the valve and port will mark the distance and the thickness of the wedge at the marks is readily measured. If the valve and port edges are irregular or not parallel to each other, the average of a number of measurements should be taken.

Smoother Running by Cushioning on Exhaust—How is smoother running of a slide-valve engine obtained by cushion on the exhaust? W. T. R.

Cushioning on the exhaust results from closing the exhaust valve before the end of the stroke. The exhaust steam thus trapped in the cylinder is gradually compressed and acts like a cushion in gradually reversing the pressure on the crosshead pin and the crankpin, and thereby reduces pounding that may be caused by admission of live steam for the return stroke of the piston. The exhaust valve is made to close earlier by moving the eccentric farther around the shaft in the direction of the rotation. All valve events are thus made earlier in the stroke, and obtaining more compression of the exhaust is necessarily accompanied by more lead, earlier cutoff and earlier release.

Control of Lighting Circuit from Three Stations—What arrangement of switches is necessary to control a lamp circuit from three different stations? J. C. L.

To control an electric circuit from three stations, use two three-way and one four-way switches connected as in diagram A. The circuit may be controlled from any number



3-WAY AND 4-WAY SWITCH CONNECTION DIAGRAM

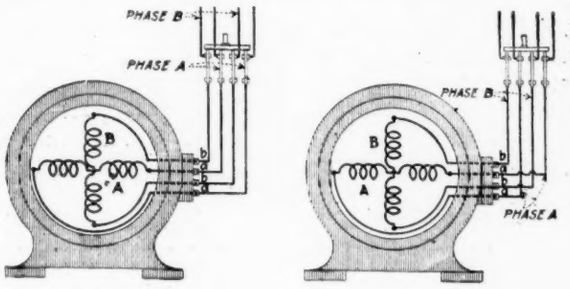
of stations by using two three-way switches at the end stations and four-way switches at the intermediate stations. Diagram B shows the connections for controlling a circuit from five different stations.

Saturated and Superheated Steam—When is steam said to be saturated and when superheated? W. R. K.

By saturated steam is meant steam that is at the evaporation temperature corresponding to its pressure. When steam is formed in a boiler and rises from the surface of the water, it is "saturated" and will remain so as long as it is in contact with the water; and any attempt to heat the steam to a higher temperature will fail, as the heat so added is transmitted to the water and merely causes evaporation. Saturated steam may be perfectly dry, and when it holds particles of water in suspension it is said to be "wet." Unless otherwise specified, the quality is understood to be "dry saturated." To effect superheating, or raising the steam to a higher temperature than the temperature of saturated steam at the same pressure, the steam must be removed from close communication with water. The number of degrees by which the temperature exceeds the temperature of the boiling point of water corresponding to the pressure is called the "degrees of superheat," and this term is used to designate the amount of superheat. For example, if steam at a pressure of 100 lb. gage, or 115 lb. per sq.in. absolute, is found to have a temperature of 420 deg. F., then, as the temperature of the boiling point of water and of saturated steam at the given pressure is 338.1 deg. F., there would be 420 — 338.1 = 81.9, or practically 82 degrees of superheat.

Reversing a Two-Phase Four-Wire Motor—In a two-phase four-wire induction motor, which connections are changed to reverse its direction of rotation? Is there any difference in the way that a squirrel-cage type motor is reversed and reversal of the wound-rotor type? J. O. R.

Any two-phase motor can be reversed by interchanging the connections on either phase of the stator winding. This



REVERSING TWO-PHASE FOUR-WIRE MOTOR

is indicated in Figs. 1 and 2. The connections of phase *A*, Fig. 2, are interchanged from that in Fig. 1, consequently will give an opposite direction of rotation. In reversing a two-phase wound-rotor type induction motor, change the stator winding connections as with the squirrel-cage type and do not change any of the rotor connections.

Pressure of Hydraulic Elevator Pressure Tank.—The pressure tank of a hydraulic elevator has a capacity of 1000 gallons and when two-thirds filled with water the pressure is 160 lb. per sq.in. The hydraulic cylinder is 18 in. diameter by 10 ft. stroke. How much pressure should the gage show after one full stroke? K. E.

Before the stroke takes place there would be 1000 ÷ 3 = 333.3 gal. or 333.3 ÷ 8.3 = 40.16 cu.ft. of space filled with air at the initial pressure of 160 lb. gage or 160 + 15 = 175 lb. per sq.in. absolute. Without any leakage one stroke of the hydraulic cylinder would remove from the tank $\frac{18}{12} \times \frac{18}{12} \times 0.7854 \times 10 = 17.67$ cu.ft. of water, and the initial volume of air would be expanded to 40.16 + 17.67 = 57.83 cu.ft. Assuming constant temperature, the absolute pressure would be inversely as the volume and after expansion of the air to the new volume the absolute pressure would be 175 × 40.16 ÷ 57.83 = 121.5 lb. absolute, or 121.5 − 15 = 106.5 lb. gage pressure.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Ammonia Condenser Data*

By HENRY TORRANCE
Vice President, Carbondale Machine Co.

This paper is to show that both the flooded atmospheric and the flooded injector types of condensers are wrong in theory and practice.

IN THE summer of 1914 the writer decided to test the value of the so-called flooded ammonia condenser, in which the ammonia vapor entered at the bottom and the liquid ammonia was drawn off at the top; also to ascertain if two coils in series, each with independent water supply, gave a still lower head pressure; that is, two coils were so connected that in one the ammonia vapor entered at the top and flowed downward, while in the other it entered at the bottom and flowed upward.

In Table I "flooded operation" means liquid taken off the top on both coils; "parallel operation" means liquid taken off the bottom on both coils, and "series operation" means liquid down one coil and up the other. The necessarily poor performance of the second coil cut down the results averaged over the two coils.

An inspection of Table I shows that it made no difference how the ammonia ran, so long as the quantity of water and ammonia remained the same.

In November, 1915, the writer tested out the flooded injector condenser and found that the injector gave no appreciable advantage. See Table II.

Atmospheric Drip or Bleeder Type Condenser

We concluded to test a drip condenser in which the liquid ammonia was drained off as fast as formed. We put a bleeder on each return bend and a valve on each bleeder. The coil tested was 2-in., 12 pipes high, 20 ft. long, and is illustrated by Fig. 1. The drip pipes were sealed as shown, so vapor could not bypass through the header, but would be obliged to pass up through the coil maintaining its velocity and efficiency.

We then made a comparative test of this drip condenser and the flooded injector condenser, which gave the results shown in Table III and Fig. 2.

From Table III and Fig. 1 it is apparent that with the same conditions of water supply and surface the drip condenser is decidedly better than the flooded injector type.

The theory of these flooded condensers, as the writer understands from their advocates, is that the water cools the pipe, the pipe cools the liquid ammonia, and the liquid cools and condenses the vapor. Let us consider the injector type of atmospheric condenser consisting of twelve runs of 2-in. pipe, 20 ft. long, total 150 sq. ft. surface and rate it at 20 tons refrigerating effect. The liquid must be cooled sufficiently low so that when it strikes the vapor it will condense it.

Thus, 20 tons at 24 lb. per hr. = 480 lb. per hr. ÷ 60 = 8 lb. to condense per minute, at 550 B.t.u. = 4400 B.t.u. per min. to be absorbed from ammonia vapor by the circulating liquid. If in doing this the liquid is raised 5 deg., the quantity of liquid circulating through the coil must be 4400 ÷ 5 = 880 lb. per min. = 176 gal., but we know 176 gal. could not flow through a 2-in. pipe under these conditions. Hence its temperature either rises considerably over 5 deg. or it does not condense all the vapor and carries much of it through the coil to condense gradually as in the ordinary condenser.

A paper was read before the Western Ice Manufacturers Convention at Kansas City on the "Economical Ice Plant of Today" and published in *Ice and Refrigeration* of April, 1915. In this the theory of this condenser was explained in the following words, referring to Fig. 3.

"The principle upon which these condensers are based is the condensation of a gas by introducing it into a body of its own liquid, and then cooling this liquid by passing it through apparatus where it comes in contact with a cool surface."

It does not seem possible that this theory is true, because the flooded system involves a triple cooling, the water has to first cool the pipe, the pipe cools the liquid, and the liquid should cool the vapor. Surely, if the pipe cooled the vapor direct it were better. We all know that ammonia under direct expansion gives a colder temperature in the room (provided the pipe contains no superheated gas) than first cooling brine and having the brine cool the room.

Furthermore, the argument that the heat transmission between liquid and liquid is better than between a vapor and a liquid (as advanced by these advocates of flooded condensers) is not necessarily true. If liquid has a poor circulation, its heat transmission may be as slow as 10 B.t.u., per hr. per. sq. ft. per. deg. difference in temperature.

Test of Shell Type Condenser: These two reasons convinced us that the above flooded system would be poorer, not better, so we put up in a test plant in Carbondale, a shell condenser, Fig. 4, connected so as to run empty, or flooded with an injector. We ran this condenser first empty, then flooded and found as theory would indicate, that the flooded system was worse, in fact very much worse, as shown in Table IV.

It does not take an expert to tell the difference; any one can see it with half an eye. Mr. Ophuls first pointed out to

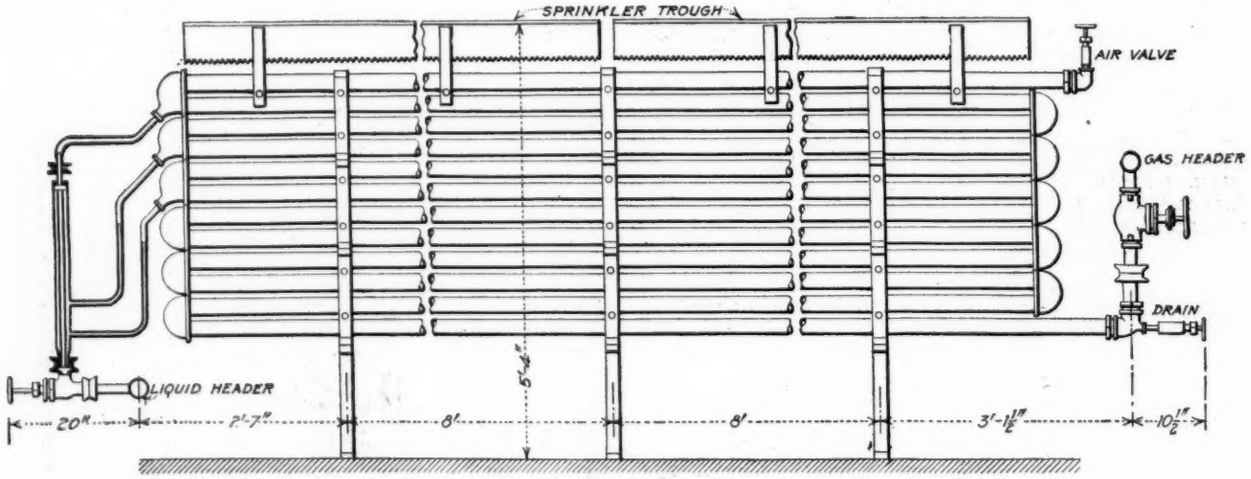


FIG. 1. DRIP-PIPE AMMONIA CONDENSER, CARBONDALE TYPE

*From the July *Journal* (delayed), American Society of Refrigerating Engineers.

the writer that condensers should run empty, and the above experiments amply prove the theory. Mr. Greene substantiated the same thing and the discussion is given in A. S. R. E. *Transactions*, 1913, pages 71 to 74, which all interested should read again.

The flooded condenser is wrong in both theory and practice. The flooded brine cooler is correct in theory because

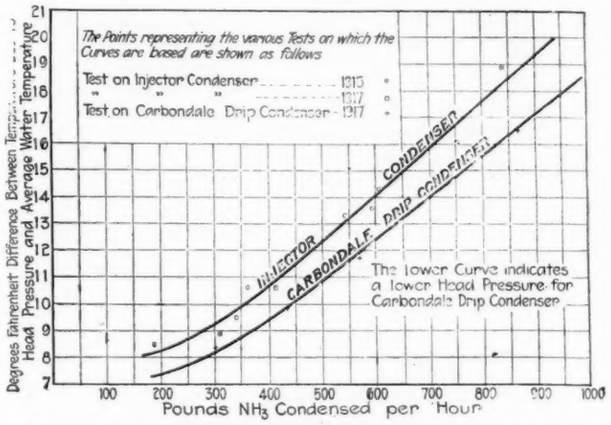

The Points representing the various Tests on which the Curves are based are shown as follows
Test on Injector Condenser
Test on Carbondale Drip Condenser - 1917
INJECTOR CONDENSER
CARBONDALE DRIP CONDENSER
The lower Curve indicates a lower Head Pressure for Carbondale Drip Condenser
Degrees Fahrenheit Difference Between Temperature Head Pressure and Average Water Temperature
Pounds NH3 Condensed per Hour

FIG. 2. CARBONDALE TESTS OF FLOODED INJECTOR TYPE CONDENSER AND OF DRIP CONDENSER

the liquid to be evaporated should touch the pipe. This flooded condenser theory was first brought to the notice of the Society at the December meeting, 1912, and was accepted as correct, and the false theory has been propagated all over the United States. The writer believes that it is time people should understand that the theory is fallacious, that the results per square foot of surface are

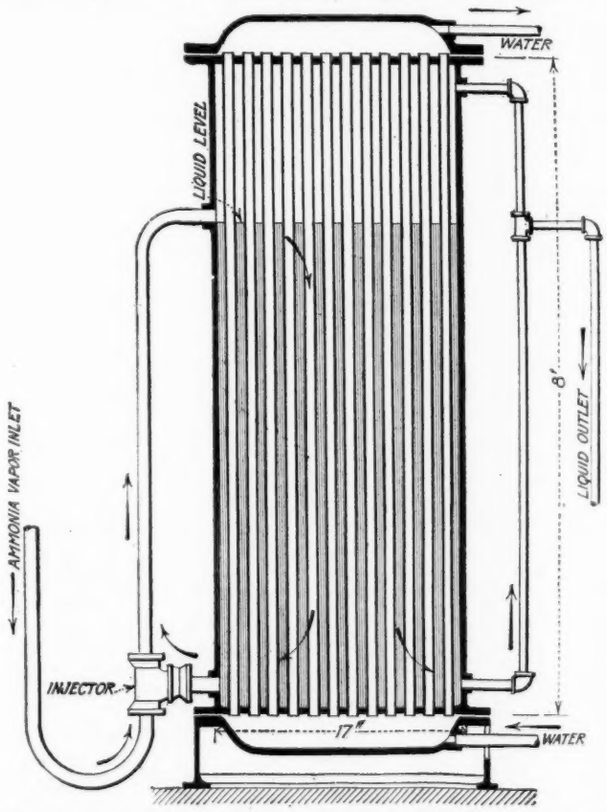


FIG. 3. FLOODED INJECTOR EXPERIMENTAL CONDENSER, SHIPLEY TYPE

poorer than in the ordinary type and considerably poorer than the drip type, besides requiring more ammonia.

In the discussion, Louis Block, inventor of the Block condenser, laid stress upon the value of high rates of heat transfer. Replying to Mr. Block, Fred Ophuls, of Ophuls, Hill & McCreery, consulting engineers, pointed out that the coefficient of heat transfer is not necessarily the most important factor in condenser design and operation, as regards efficiency.

Unfortunately, lack of space makes it impossible to give verbatim the discussion; some of the chief points are given, however.

Louis Block—To obviate the necessity of regulating (the gas flow to the condenser) I now build the condenser as shown in Fig. 5. The friction due to the lowest three pipes with their return bends is enough so that I can now leave the valve on the inlet pipe wide open, the hot gas header distributing the gas to all the condensers equally. At the fourth pipe from the bottom the pull begins, due to the counter-current. The gas wants to rush up to the top pipe of the condenser, and at the fourth pipe it begins to pull,

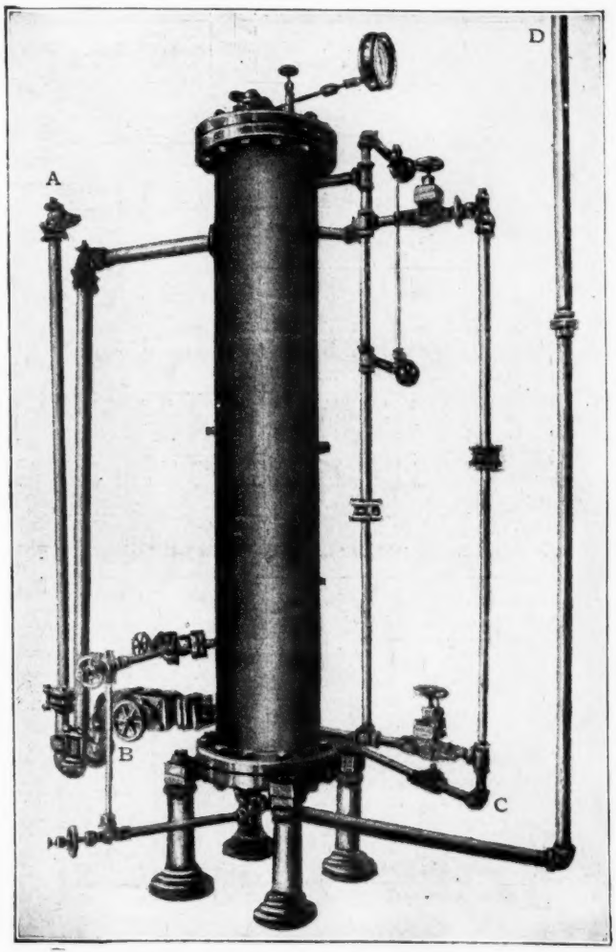


FIG. 4. EXPERIMENTAL VERTICAL SHELL CONDENSER
A.—Ammonia gas inlet. B.—Injector. C.—Liquid outlet. D.—Water supply.

but now the gas must overcome the friction in the three lowest pipes and their return bends. A 1¼-in. inlet pipe is just sufficient to supply to a condenser all the gas it can condense.

In 1914 I tested a condenser, Fig. 6, which was provided with thermometers on the return bends. The condenser was 22 pipes high; the thermometer indications show what takes place inside the pipes. This condenser was built by the Vilter Company in 1910. The temperature of hot gas was 180 deg.; the temperature of the liquid was 80 deg.; the temperature of the water to the condenser was 72 deg.; the temperature of the water off the condenser was 90 deg.; the temperature in the third pipe was 92 deg. and it continued 92 deg. all the way up to the sixth pipe from the top; there it was 91 deg. In the fourth pipe from the top it was 90 and at the top it was 80 deg. So you see there is a condensing zone which stretches over 14 pipes in which

TABLE I. TESTS OF DOUBLE PIPE CONDENSERS, FLOODED AND NOT FLOODED—1914

Method of Operation	Tons Refrigeration by Brine 200 B.t.u. per Min.	Sq.Ft. Surface per Ton	Head Pressure Pound Gage	Temperature Due to Head Pressure, Deg. F.	Water Inlet, Deg. F.	Water Outlet, Deg. F.	Liquid Ammonia, Deg. F.	Difference Between Temperature Due to Head Pressure and Water, Deg. F. Inlet Col. 5—Col. 6	Outlet Col. 5—Col. 7	Average	Pounds Liquid Condensed per Hour Calculated from Tonnage	Water Per Min., Gal.
1	2	3	4	5	6	7	8	9	10	11	12	13
Flooded	19.0	7.0	125.0	74.3	60.1	66.0	71.1	14.2	8.3	11.25	475	76
Parallel	18.1	7.4	125.3	74.5	61.0	66.5	72.1	13.5	7.0	10.25	453	71
Series	19.0	7.0	126.5	75.0	60.4	65.9	70.3	14.6	9.1	11.85	474	76
Flooded	14.5	9.0	112.0	69.1	59.5	63.0	66.6	9.6	6.1	7.85	359	93
Parallel	9.6	14.0	110.6	68.0	60.2	63.2	66.5	7.8	4.8	6.30	238	90
Series	10.3	13.0	113.4	69.5	60.0	63.6	66.0	9.5	5.9	7.70	255	88
Series	11.9	11.2	114.0	69.8	60.4	64.4	65.6	9.4	5.4	7.40	294	57
Parallel	10.6	12.6	113.8	69.7	59.6	64.8	68.3	10.1	4.9	7.50	262	64
Flooded	9.6	14.0	114.0	69.8	60.0	64.9	68.0	9.8	4.9	7.35	237	56

Details of pair of condenser stands used: Two coils, double-pipe type, 1¼-in. and 2-in. pipes, each coil eight pipes high, 20 ft. long. Total outer surface of 16 1¼-in pipes = 134 sq.ft.

TABLE II. TESTS OF FLOODED SHELL CONDENSER, WITH AND WITHOUT INJECTOR, 1915

Method of Operation	Sq. Ft. Condenser Surface	Tons Refrigeration by Brine 200 B.t.u. per Min.	Sq.Ft. per Ton	Head Pressure, Lb. Gage	Temperature Due Head Pressure, Deg. F.	Temp. Liquid Ammonia from Cond.	Condenser Water, Deg. F. Inlet	Outlet	Range	Average	Difference Between Temperature Due Head Pressure and Average Water	Pounds Ammonia Condensed per Hour Total	Per Square Foot	Per Sq.Ft. per 1 Deg. F. Aver. Temp. Diff. Water and Ammonia	Temperature Gas at Inlet	Water per Min., Gal.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
*	150	10.4	14.4	128.4	75.8	72.1	59.7	69.9	10.2	64.8	11.0	265.0	1.77	0.161	101.0	25.5
**	137	9.5	14.4	127.3	75.3	70.4	59.6	69.4	9.8	64.5	10.8	256.9	1.87	0.173	99.2	25.5
*	150	13.5	11.1	121.5	72.9	70.0	59.8	66.5	6.7	63.1	9.8	339.9	2.37	0.232	100.9	49.9
**	137	13.1	10.4	123.5	73.7	69.9	60.2	67.2	7.0	63.7	10.0	339.4	2.48	0.248	99.5	49.9
*	150	22.1	6.8	133.7	77.9	73.0	59.8	68.2	8.4	64.0	13.9	593.2	3.95	0.284	113.7	74.6
**	137	27.4	5.0	135.3	78.5	74.2	59.7	68.1	8.4	63.9	14.6	662.1	4.80	0.329	114.6	74.9
*	150	15.4	9.74	125.1	74.4	70.9	59.9	67.2	7.3	63.6	10.8	360.0	2.40	0.222	101.8	52.1
*	150	27.8	5.40	147.0	82.9	78.9	60.8	72.3	11.5	66.6	16.3	751.0	5.00	0.307	124.3	74.5
**	137	28.5	4.81	144.0	81.8	77.9	60.1	71.8	11.7	66.0	15.8	758.0	5.53	0.350	123.1	74.9
*	150	35.9	4.10	153.8	85.4	80.9	60.6	72.1	11.5	66.4	19.0	992.0	6.61	0.348	139.0	102.4
**	137	36.5	3.75	154.0	85.5	80.6	60.0	71.2	11.3	65.6	19.9	1012.0	7.39	0.371	135.0	103.3

*With injector **Without injector.

TABLE III. COMPARATIVE TESTS OF FLOODED SHELL AND DRY ATMOSPHERIC DRIP TYPE OF CONDENSERS

Sq. Ft. Condenser Surface	Tons Refrigeration by Brine 200 B.t.u. per Min.	Sq.Ft. per Ton	Head Pressure, Lb. Gage	Temperature Due Head Pressure.	Temp. Liquid Ammonia from Cond.	Condenser, Water, Deg. F. Inlet	Outlet	Range	Average	Difference Between Temperature Due Head Pressure and Average Water	Pounds Ammonia Condensed per Hour Total	Per Square Foot	Per Sq.Ft. per 1 Deg. F. Aver. Temp Diff Col. 12	Temperature Gas at Inlet	Water per Min., Gal.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Flooded Injector Type, Vertical Shell Condenser, 1917.															
150	12.4	12.10	123.3	73.5	71.4	60.2	68.9	8.7	64.6	8.9	307.5	2.05	0.230	104.3	38.6
150	8.5	17.65	120.9	72.5	72.9	60.1	67.9	7.8	64.0	8.5	189.2	1.26	0.148	97.9	25.8
150	16.6	9.03	125.9	74.5	72.5	59.6	68.1	8.5	63.9	10.6	411.7	2.75	0.259	103.2	51.2
150	22.2	6.75	131.6	76.8	75.9	59.3	67.6	8.3	63.5	13.3	543.4	3.62	0.273	107.8	61.1
150	24.5	6.13	136.1	78.6	77.3	60.1	68.5	8.4	64.3	14.3	605.6	4.04	0.283	109.2	72.2
150	33.9	4.43	146.8	82.7	81.0	59.6	68.0	8.4	63.8	18.9	841.0	5.62	0.297	118.1	101.0
Atmospheric Drip Type, Condenser, 1917															
150	12.3	12.20	122.2	73.0	71.9	60.2	68.5	8.3	64.6	8.4	301.6	2.01	0.239	103.4	37.2
150	8.5	17.65	118.5	71.4	69.1	59.9	68.1	8.2	64.0	7.4	201.4	1.34	0.182	101.2	26.6
150	17.0	8.83	124.9	74.1	72.1	60.1	68.3	8.2	64.2	9.9	433.2	2.89	0.292	106.8	50.1
150	23.3	6.43	129.7	76.1	75.0	59.7	69.0	9.3	64.4	11.7	569.1	3.80	0.325	108.7	62.3
150	26.1	5.75	134.4	77.9	75.9	60.1	68.7	8.6	64.4	13.5	638.8	4.23	0.316	109.5	74.8
150	34.8	4.32	142.6	81.1	79.1	60.1	69.2	9.1	64.6	16.5	867.1	5.78	0.350	117.1	101.5

TABLE IV. TESTS OF VERTICAL SHELL CONDENSER, FLOODED AND NOT FLOODED

Sq. Ft. Condenser Surface	Tons Refrigeration by Brine 200 B.t.u. per Min.	Sq.Ft. per Ton	Head Pressure, Lb. Gage	Temperature Due Head Pressure.	Temp. Liquid Ammonia from Cond.	Condenser, Water, Deg. F. Inlet	Outlet	Range	Average	Difference Between Temperature Due Head Pressure and Average Water	Pounds Ammonia Condensed per Hour Total	Per Square Foot	Per Sq.Ft. per 1 Deg. F. Aver. Temp. Diff. Water and Ammonia	Temperature Gas at Inlet	Water per Min., Gal.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Shell Type Condenser, Flooded, 1917															
77	7.01	11.00	137.6	79.2	79.9	59.9	65.1	5.2	62.5	16.7	160.0	2.07	0.124	93.6	32.1
77	5.70	13.50	131.1	76.6	76.9	60.1	64.2	4.1	62.15	14.45	138.3	1.79	0.123	93.8	31.7
Shell Type Condenser, Not Flooded, 1917															
77	8.85	8.7	119.9	72.0	72.2	59.6	67.3	7.7	63.45	8.55	229.0	2.97	0.347	97.9	30.7
77	7.73	9.96	118.2	71.3	70.1	59.6	66.4	6.8	63.00	8.30	210.6	2.73	0.329	99.2	30.7

the temperature is exactly the same, while, of course, the temperature of the water changes; so there may be a heat transfer in some of these pipes which is still higher than the average heat transfer which I previously mentioned. *This condenser at the time did 56 tons of work per stand,* and that perhaps accounts for the rather high temperature of the discharged liquid, because it was forced some. There were two stands of condensers going with 150 gal. of water per minute showered over the two, and the water was heated 18 deg.; the machine was a Vilter compressor, 17 by 32 in., running at 60 r.p.m. with 21 lb. back pressure, doing 112 tons of work. The head pressure was 172 lb., which, according to Macintire, corresponds exactly to 92 deg. F., giving 18 deg. difference.

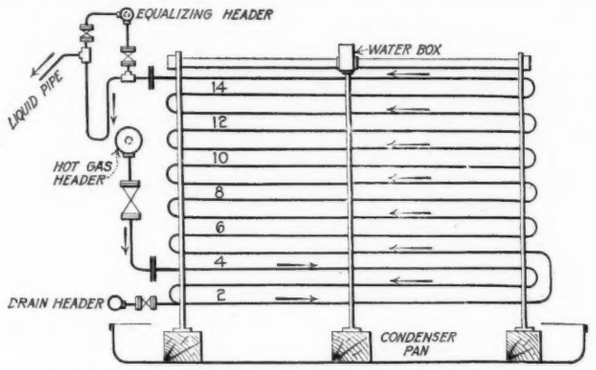


FIG. 5. CONNECTIONS TO THE PRESENT BLOCK CONDENSER

Mr. Block said that later experience has shown that it is unnecessary to make a condenser so high as 22 pipes.

F. L. Fairbanks—We have gone over our tests in the past year with three different types of condensers. One was the 1000-ton jet, another the injector shell, another was the so-called double-pipe flooded injector. The immediate effect in every case of introducing liquid was to run the head pressure up until enough had been injected to condense all of the gas, when it began to come down again. By figuring the difference in heat and allowing a reasonable temperature rise of the liquid, one would find that it took about 50 to 1. Our tests corroborate Mr. Torrance's results. In no case, even when pumping the liquid anhydrous ammonia through the coils at any velocity and in any known quantity, were we able to reduce the head pressure to that obtained with the dry type. In all three types of condensers, it went up from 8 to 20 lb. invariably, and we had all facilities for getting velocities and measuring quantities that it is possible to have, pumping the liquid with a double-acting Christine pump.

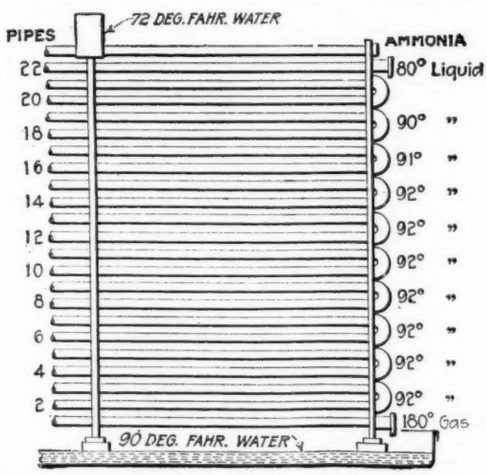


FIG. 6. MR. BLOCK'S 22-PIPES HIGH CONDENSER

We have found that at the ammonia condenser a foot of surface is the cheapest thing we have in our plant; it is the one thing that produces economy, particularly on large machines, so that we do not try to get the wide range Mr. Block speaks of. We keep our water temperature range between 5 and 10 deg., or 6 deg. usually. We find that when we get an increased range on the suction and the discharge side, we pay for it in the coal pile. The heat transfer per square foot of pipe can be made anything. If you increase the transmission per square foot of surface, you pay for it through the compressor to the coal pile. Power is a continuous process, and the investment in surface is an initial one. We make it a practice in our plant, and find it excellent economy, to use every foot of condenser surface available to secure the lowest possible head pressure. The result is that our compressors are much more efficient, require less horsepower, and operate with a more favorable volumetric efficiency, etc. In these respects we have not found any way of using the jet condenser so it will take the place of a surface condenser. In using a centrifugal wheel type of condenser, we found that the more nearly a dry surface and a high gas velocity is obtained, the greater will be the transmission per square foot and the more efficient is the condenser. Any collection of liquid on the condensing surface decreases directly the transmission of heat, because it acts as a blanket between the gas and the metal.

At this point Mr. Block mentioned that the high velocity in the Block condenser was responsible for its efficiency, whereupon Mr. Fairbanks and others contended that the high velocity was not had without cost in power and coal, inasmuch as velocity was had because pressure was converted to velocity. The discussion ended by Mr. Block inviting Mr. Fairbanks to set up a Block condenser and test it under Mr. Block's direction. Mr. Fairbanks accepted.

American Institute of Electrical Engineers

The American Institute of Electrical Engineers held its 345th meeting in the auditorium of the Engineering Societies Building, New York City, Friday evening, Jan. 10, 1919. Comfort A. Adams, president of the institute, opened the meeting by introducing Major General George O. Squires, Chief Signal Officer of the United States Army. General Squires presented his paper "Aëronautics in the United States, 1918," in which he reviewed the development of military aëronautics in this country up to the date of signing the armistice, Nov. 11, 1918. Some of the significant features brought out in this paper are as follows:

The War Department's first heavier than air flying machine was produced approximately ten years ago, but for the eight years that followed, less than $1,000,000 was appropriated for aëronautics. Up to June, 1918, approximately 1000 Liberty engines had been produced. By Dec. 31, 1918, more than 16,000 of these engines were manufactured. Up to the date of the signing of the armistice, Nov. 11, 1918, more than 14,000 Liberty engines had been produced, totaling 5,700,000 hp. So well recognized did the value of the Liberty engine become that at the time of the signing of the armistice the Allies had on order 16,741 Liberty engines and were constantly endeavoring each to increase their rate of monthly delivery.

The experimental development of the Liberty engine has been in charge of a department entirely separate from that dealing with its production. The work of this department has resulted in a continuous improvement of the power output and performance characteristics of the Liberty twelve-cylinder, to such an extent that 526 hp. have been obtained with special fuel and detail changes; certainly a remarkable increase from the 335 hp. which the original design was intended to yield. While the weight of the service engine per horsepower has remained at approximately 2 lb., the maximum present development had reduced this figure to 1¼ lb.

In closing General Squires said:

"The Liberty engine stands today as an achievement which for daring, constructive imagination and farsightedness will ever be a cause of pride to the American people."

After General Squires presented his paper Captain Albro, of the Signal Corp, United States Army, gave a talk on the production of Liberty motors and airplanes in this country, which was illustrated with lantern slides and moving pictures.

The Engineering Index Now Conducted by the A. S. M. E.

The *Engineering Index*, published for 25 years in the *Engineering Magazine* and its successor, *Industrial Management*, and universally regarded as the standard index to engineering periodical literature, has been acquired by the American Society of Mechanical Engineers, and hereafter will be compiled and published by that society. The first issue of the *Index* under the new management appears in the January number of the *Journal*.

As heretofore, the *Engineering Index* will be regularly issued in three different forms: (1) As a part of the *Journal* of the society; (2) as a separate monthly publication for libraries or individuals desiring to clip the items for indexing purposes; (3) as an annual volume in which all the items for the year are collected.

The *Engineering Index* originated with Prof. J. B. Johnson, of Washington University, St. Louis, Mo., in 1883 and for 12 years was prepared under his direction and published by the Association of Engineering Societies. It was then taken over by the Engineering Magazine Co. of New York and has since had the personal attention of John R. Dunlap, the president of that company, who has found it to be a widely appreciated undertaking by engineers throughout the world. The development of his magazine in the specialized field of industrial management, however, made it seem desirable to place the *Index* in the hands of an engineering organization covering a broader field and serving engineers engaged in more varied activities. The society immediately recognized the opportunity extended and purchased the *Index*, thus bringing to the *Journal* the prestige, name and other rights and privileges of what has been regarded as the leading index in the field. This establishes the *Engineering Index* on a secure and noncompetitive basis as a logical society activity.

Through the facilities afforded by the magnificent library of the Engineering Societies, which regularly receives 1100 periodicals from all parts of the world, the society has unlimited possibilities in publishing the *Index*. These periodicals comprise one of the most complete collections of current engineering literature in the world—in not less than ten languages and received from 37 countries. The indexing of engineering articles can be best accomplished by a professional organization, and the society will consider it one of its greatest services to place at the disposal of engineers, through the *Engineering Index* in the *Journal*, the means for using the wealth of data and general information published from month to month in the world's technical press.

The plan of classification to be used is as follows: The articles are listed in the general field of engineering to which they belong, and are then grouped together under the particular branch of the general subject. The following classifications give an adequate idea of the scope of the *Engineering Index* as it will be carried in the *Journal:* Mechanical Engineering, 31 subheads; Electrical Engineering, 11 subheads; Civil Engineering, 9 subheads; Mining Engineering, 14 subheads; Metallurgy, 7 subheads; Aëronautics, 19 subheads; Marine Engineering, 4 subheads; Organization and Management, 13 subheads; Industrial Technology, Railroad Engineering, 15 subheads; Munitions and Military Engineering; General Science, 3 subheads.

One Combined Engineering Society

Practically all engineers are agreed that the engineering profession should be organized more closely than at present. Only by organized and combined efforts can tangible results be accomplished. It is now divided into civil, mechanical, electrical, chemical, mining and "what not" societies working independently.

A solution of the problem is that all of the present recognized societies get together and form one combined engineering society, keeping the following points in mind: (1) Do not destroy the identity of the present societies; (2) take the good points of the present societies, add what is new and desirable, and get rid of the undesirable features.

The work of the combined organization should be to supplement the work of the separate societies now existing, taking up questions that they are too busy to accomplish, and centralize others that can be accomplished better by combined efforts. Technical work, advancement of the arts and sciences, would be accomplished in each individual society as at present. The general society would take care of such subjects as status of the engineer, general welfare, professional ethics, employment agencies, relation of the engineer to the general public, social benefit.

There is now no organization in existence to do such work. Such organizations as were and are in existence were for winning the war. They have accomplished their purpose, but they are not organized and useful to do the work which the engineer needs and should demand. The time to do this is now. The reconstruction period is on. The engineer ought to be a large factor in this. He did well during the war, showing what could be done by coöperation. The momentum that has been gained should not be lost.

The Duluth Engineers' Club, after ascertaining the sentiment of various engineering societies and finding that an urgent desire in line with the foregoing exists, has unanimously passed a resolution favoring such organization and has appointed a committee to further that end and to compile complete data regarding the sentiment of the profession throughout America on the subject.

A request is made that engineering societies in general bring up this matter at their next meetings for a favorable expression in the form of a vote on the question and advise the Duluth Engineers' Club of the results. The committee consists of O. H. Dickerson, member of the American Society of Civil Engineers; F. S. Heald, member of the American Institute of Electrical Engineers; J. A. Graves, member of the American Chemical Society; F. H. Linley, member of the American Society of Mechanical Engineers; D. E. Woodbridge, member of the American Institute of Mining Engineers.

Soft-Coal Output Increased Six per Cent. in 1918

The lowest weekly production of bituminous coal reported in the last three years was brought about by the time lost on account of the Christmas holidays during the week ended Dec. 28, according to the Geological Survey. Estimates for this week place production at 6,385,000 net tons, 3,746,000 net tons, or 37 per cent. behind production of the week ended Dec. 21, and 3,352,000 net tons, or 34 per cent. behind production of Christmas week of last year. The average daily production (five days) is estimated at 1,277,000 net tons as compared with 1,913,000 net tons for this coal year to date and 1,763,000 net tons for the same period of 1917.

Total production of bituminous coal for the period Apr. 1 to Dec. 28 is estimated at 447,748,000 net tons, as against 412,561,000 net tons during the period Apr. 1 to Dec. 28, 1917, or an increase of 35,187,000 net tons.

The production of bituminous coal and lignite in the calendar year 1918 is estimated at 585,883,000 net tons, an increase compared with 1917 of 34,092,000 net tons, or 6.2 per cent. Four states reported decreases—Georgia, Iowa, Missouri and Texas. The most important increases were: Pennsylvania, 11,264,000 tons; Ohio, 5,715,000 tons; Illinois, 5,064,000 tons; West Virginia, 4,908,000 tons. The estimates indicate that West Virginia still retains second place as a coal producer, but the lead is so small that final returns may place Illinois in this position, which was assumed by the State of West Virginia in 1908.

The loss of time brought about by the Christmas holidays caused anthracite production during the week of Dec. 28 to decrease more than 500,000 net tons, compared with the production of the week preceding, and was approximately 200,000 net tons lower than the production during the corresponding week of 1917. For the period Apr. 1 to Dec. 28 the production of anthracite is estimated at 73,830,000 net tons which is 1,606,000 net tons or slightly more than 2 per cent. below the production of a similar period of the previous year.

Report of Fuel Administration on Liberty Fuel

Repeated requests for information regarding Liberty fuel have resulted in the issuance of the following statement by the Fuel Administration:

Tests made in the aëronautic laboratories of the United States Army resulted in information that the fuel was made up of approximately 65 per cent. of benzol, 25 to 30 per cent. of kerosene, and the remainder of a small percentage of amyl acetate and probably naphthalene and alcohol, together with, perhaps, small quantities of dissolved solids and other volatile liquids as yet undetermined.

On this analysis the available supply of the fuel must depend on the available supply of benzol, its chief constituent. Investigation showed that if the total production of benzol (3500 bbl. a day) were so used, the total production of Liberty fuel would be about 2 per cent. of the present output of gasoline, which is approximately 90,000,000 bbl. a year. Benzol, however, has other uses.

A gumming and corrosion test, also conducted in the aëronautic laboratories of the army, showed no perceptible corrosion, but a tremendous amount of gumming; that is, 0.4 per cent., accompanied by extensive fuming and penetrating odor. The tendency of the gummy residue in the fuel would be to plug up carburetors, Fuel Administration experts said.

In the same army-laboratory test, crystallization was found to be set in at 18 deg. F. and to be practically complete at 15 deg. F. Boiling started at 175 deg. F. as against an initial boiling point of not more than 140 deg. for motor gasoline indicating better starting qualities for motor gasoline.

The Bureau of Standards stated: "The results of tests in an aviation engine indicated that Liberty fuel compared with gasoline fulfilling the export specifications for aviation gasoline, will, when consuming 10 per cent. greater weight of fuel per horsepower, develop about 3 per cent. greater horsepower. The spark plug used in Liberty fuel showed a slightly greater carbon deposit than the plugs used in the run of export gasoline.

Information furnished the Fuel Administration by the Navy Department stated that a flight of forty minutes was made with the fuel, and that no observations were made which would show that the fuel would accomplish any other results than to operate the engine in a manner similar to the aviation fuel which had been used. Arrangements were made, the Navy Department reported, for sufficient quantities of the fuel to make fuel tests, but the fuel was not supplied.

A letter from Benedict Crowell, Assistant Secretary of War, said: "The situation has not reached such a stage that this office feels that any definite announcement can be made, or that it can express a definite opinion as to the true merits of the fuel.

The Bureau of Mines reported that it was approached, but, on asking for the formula in order to compound the material and being refused, dropped the matter, declining to act under the circumstances.

Personals

E. B. Mead, who for the last five years has been acting as salesman and efficiency engineer for the Vacuum Oil Co., has resigned and has accepted a position as assistant to the chief steam engineer at the plant of the Cambria Steel Co.

H. K. Gowdy, for many years chief engineer of the Pittsburgh Railways Co. and for the past three years in charge of the technical department of the Pittsburgh office of the Vacuum Oil Co., has been appointed chief steam engineer of the Cambria Steel Co.

Business Items

The Walworth Manufacturing Co., of Boston, has recently purchased the business of Hunter & Dickson Co. at 241-247 Arch St., Philadelphia, and will operate it as one of its branches.

The Quigley Furnace Specialties Co. has opened a branch office in Providence, R. I., at 302 Turks Head Building, in charge of F. W. Reisman, who has been the Quigley company's eastern New England representative for "Hytempite" (high temperature firebrick cement) and insulating brick as well as the air-transport system for distributing and burning powdered coal and other fuels.

Trade Catalogs

The Walter A. Zelnicker Supply Co., of St. Louis, Mo., has issued its Bulletin No. 250 for January, containing a full reference list of its supplies.

Tar Cameras for Colorimetric Tar Determination. Steere Engineering Co., Detroit, Mich. Bulletin No. 35. Pages 11, 8½ x 11 in. Illustrating and fully describing the process. Copy of bulletin free upon application.

Giant Semi-Diesel Fuel Oil Engine. Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin 34-W. Pages 31, 6 x 9 in. Describing and illustrating this type of engine; horsepower ratings and general dimensions given in tables.

Space and Speed in Steel Buildings. Milliken Bros. Manufacturing Co., Inc., New York. Pages 23, 6¼ x 9¼ in. Describing the standardized truss unit system of building construction as designed and manufactured by this company.

The Tide Water Oil Co., of New York City, has recently issued a 100-page Veedol book on the "Lubrication of Internal Combustion Engines." This is the fourth edition of this book, revised and brought up to date, with additional chapters on airplane engines, farm tractors, grease and gasoline, as well as actual facts about lubricating oils for the layman and technical engineer. It is copiously illustrated and a copy will be sent free upon request to anybody interested.

Leeds & Northrup Co., Philadelphia, has issued a 60-page illustrated catalog No. 87, "The Potentiometer System of Pyrometry and Temperature Control," describing a system of pyrometry and temperature control in which the potentiometer method is employed for measuring the electromotive force of thermocouples. This catalog also gives a description of potentiometer indicators, curve drawing recorders, multiple-point recorders, temperature control apparatus, transformation point apparatus, precision potentiometers, thermocouples and pyrometers.

New Construction

PROPOSED WORK

Vt., Bellows Falls—The Bellows Falls Power Co. plans to build a hydro-electric plant at Pockhingham. R. Y. Fitzgerald, 50 Congress St., Boston, Mass., Secy.

Vt., St. Johnsbury—The Twin State Gas & Electric Co., 55 Congress St., Boston, Mass., plans a water power development on the Passumpsic River here. H. L. Olds, Vice-Pres.

Mass., Campello—A. E. Kieth & Co. will receive bids about March 10, for the construction of a power plant. Estimated cost, $56,000. Jenks & Ballou, 735 Grosvenor Bldg., Providence, R. I., Engr.

N. Y., Baldwinsville—The Seneca River Power Co. has increased its capital stock from $50,000 to $100,000 to provide for improvements and extensions to its plant. J. R. McIntyre, Supt.

N. Y., Buffalo—J. B. Laird, 747 Ellicott Sq., is in the market for three 200 hp., 150 lb. pressure boilers, or two 250 hp. boilers of similar type, also one 200 hp. motor, 25 cycle, 3 phase, 2200 volts, 500 r.p.m.

N. Y., Elmer—The Willys-Morrow Co. plans to build a 30 x 40 ft. addition to its boiler house. Estimated cost, $5000.

N. Y., Hoffman Island—L. E. Coffer, Health Officer, Port of New York, will receive bids until Jan. 25 for setting 2 boilers, etc., at the Quarantine Station, here.

N. Y., New York (Borough of Brooklyn)—W. Higgenson, Arch., 21 Park Row, Manhattan, will receive bids until Jan. 27, for the construction of a 1-story, 50 x 55 ft. power house addition on Classen Ave., for Julius Kayser, 45 East 17th St., Manhattan. Estimated cost, $60,000.

N. Y., New York (Borough of Queens)—The Board of Education, 500 Park Ave., Manhattan, will install a steam heating system in the 3-story, 105 x 108 ft. school, which it plans to build on Colonial Ave. between Livingston and Meteor St., Long Island City. Total estimated cost, $200,000. C. B. J. Snyder, Municipal Bldg., Manhattan, Arch. and Engr.

N. Y., New York—The Beth Israel Hospital, 70 Jefferson St., will install a steam heating system in the 16-story, 175 x 200 ft. hospital which it plans to build on Livingston Pl. between 16th and 17th St. Total estimated cost, $1,000,000. Louis Abramson, 220 5th Ave., Engr.

N. Y., Thiells—Frank A. Vanderlip, Pres. of Bd. of Managers of Letchworth Village, will receive bids until March 4, for the construction of an additional power house and equipment, consisting of new boilers, piping, feed water heaters, feed water filter, feed water meter, feed pump, steam turbine, valves, etc.; also underground piping, with pipe ranging from 2 in. to 20 in. Total estimated cost, $300,000.

N. J., Laurel Hill—The Board of Chosen Freeholders of Hudson Co., Jersey City, has had plans prepared for the construction of a 100 x 185 ft. power plant here, to furnish county with lighting service.

N. J., Linden—The Transatlantic Chemical Co. will install a steam heating system in the 2-story, 100 x 150 ft. factory, which it plans to build. Total estimated cost, $100,000.

Penn., Harrisburg—Bernard Schmidt, 13th and Walnut St., plans to build a power house, in connection with the new baking plant.

Md., Glenarm—The F. H. Copper Co. is in the market for 75-hp. boilers.

W. Va., South Charleston—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will receive bids until Jan. 24 for installing 3 reversible and variable motors in the Navy Yard here; Schedule No. 7681½.

W. Va., Wheeling—The Wheeling Electric Co., controlled by the American Gas & Electric Co., 30 Church St., New York City, N. Y., plans to build a new electric plant. Estimated cost, $750,000. John B. Garden, Gen. Mgr.

Fla., Bradentown — The city is in the market for a steam driven air compressor, air-lift pump and two 11 hp. Westinghouse motors for operating a bridge.

Ala., Birmingham—The Alabama Canning Co. is in the market for 50-hp. boilers and 12-hp. engines. William C. Hale, Secy.

La., Homer — George Lewis is in the market for equipment for a power plant, grinding plant, etc.

Ohio, Cleveland — The Cleveland Telephone Co., West 3rd St. and Champlain Ave., plans to construct new building, installing duplicates of all apparatus and cutting over; also switchboards to handle 13,000 lines.

Ohio, Cleveland—The Woodmen of the World, c/o W. S. Ferguson Co., Arch., 1000 Euclid Bldg., will install a steam heating system in the 3-story, 80 x 130 ft. club house, which they plan to build on East 79th St. and Euclid Ave. Total estimated cost, $200,000.

Ohio, Toledo — The Standard Sanitary Manufacturing Co. is in the market for a hand power hydraulic press, having a capacity of 100 tons, for putting on and taking off car wheels.

Ill., Chicago—The Acme Steel Goods Co., 2324 Archer Ave., plans to build a 1-story boiler house, pump house, etc., in connection with the additional unit which it plans to build to its hoop mill on 134th St. and Indiana Ave. Total estimated cost, $30,000.

Ill., Chicago—The Art Metal Manufacturing Co., 514 South Green St., is in the market for a power bending machine to form tubes.

Ill., Chicago—The Trustees of the University of Chicago, 134 South La Salle St., plan to build an addition to the existing power plant, or a new plant on the Illinois Central R.R. tracts near 58th St. Estimated cost of new plant, $2,000,000.

Wis., Eau Claire—The Chippewa Power Co., incorporated with a capital of $200,000, plans to build a hydro-electric power plant and develop power on the Chippewa River.

Wis., Galesville—The Davis Mill Co. plans to build an addition to its power house, and is in the market for a 100 hp. engine. B. W. Davis, Mgr.

Wis., Janesville—The Board of Supervisors of Rock County plan to build a 104 x 116 ft. hydro-electric power plant near here. Van Ryan & DeGelleke, Caswell Bldg., Milwaukee, Arch.

Wis., Milwaukee—The Storage Battery Service Co., 137 Oneida St., plans to build a 1-story, 60 x 127 ft. service station at 596 Jefferson St. Estimated cost, $25,000. R. E. Oberst, 353 National Ave., Arch.

Wis., Portage—The Water Commission will receive bids until Jan. 31st. for installing 1 high pressure fire tube boiler, diameter 60 ft., length 16 ft., complete with front, grates, etc.; also to repair and re-flue the 2 boilers of the same dimensions now installed in the pumping station. H. V. Tennant, Supt.

Wis., Wausau — The Wisconsin Valley Electric Co. has had plans prepared for the construction of a power dam. M. C. Ewing, Mgr.

Iowa, Cedar Rapids—The Iowa Electric Co. plans to build a high tension line connecting its hydro-electric plant at Anamosa with the steam generating plant at Maquokato. John I. Reed, Gen. Mgr.

Ark., Little Rock—The Little Rock Railway & Electric Co., 115 West 4th St., controlled by the American Cities Co., is in the market for a 5000 kw. turbine, to be installed in its power house. C. J. Griffith, Gen. Mgr.

Mo., Excelsior Springs — The Excelsior Springs Light & Power Co. plans to extend its electrical system to Holt, Kearney, Lawson and other cities. George W. Irey, Ch. Engr.

Mo., Fulton—The Board of Managers of the State Hospital will apply to the Legislature for an appropriation for the construction of a new power house and equipment. Estimated cost, $67,000.

Mo., St. Louis—The American Packing Co., Garfield Ave., plans to build a 1-story, 42 x 70 ft. boiler plant.

Mo., Sikestown—The City Council plans an election in April to vote on a bond issue for the construction of an electric-light plant.

Okla., Kingfisher—The city will soon receive bids for electrical improvements. Estimated cost, $50,000. Black & Veatch, 507 Interstate Bldg., Kansas City, Mo., Engr.

Okla., Muskogee—The city plans to install new equipment in the pumping station, in connection with the improvements it plans to the water-works. Estimated cost, $200,000.

Okla., Okmulgee—The Okmulgee Ice & Light Co., controlled through stock ownership by the American Public Service Co., is in the market for a 1250-kva. generator, two 400-hp. boilers and other machinery. C. H. Kretz, Mgr.

Okla., Tishomingo — The city plans to build an electric-light plant. Estimated cost, $18,000. Address the Mayor.

Utah, Helper—The city plans to reconstruct the intake works and penstock for the municipal hydro-electric plant destroyed by the recent flood. Estimated cost, $10,000.

Ariz., Humboldt—The Humboldt Improvement Co. has been authorized by the State Corporation Commission to take a loan of $200,000 for the construction of electric-light and water plants to serve Humboldt.

Cal., Newport Beach—The Board of Trustees plans to build an electrically operated pumping plant in connection with the new municipal sewerage system. Total estimated cost, $173,000.

Ont., Holstein—Buller & Brebnor plan to install electrical equipment in their broom and handle plant and are in the market for motors, machinery, wiring and all general equipment.

Ont., London—E. V. Buchanan, Gen. Mgr. of the Utilities Comn., will receive bids about March 15, for the construction of an addition to its hydro-station. Estimated cost, $60,000.

Ont., Toronto—S. L. B. Lines, 243 College St., is in the market for a 37 in. foot-power squaring shears.

Alta., Grand Prairie—The Grand Prairie Electric Light Co. is in the market for a new engine and will install a new alternating current system.

Porto Rico, San Juan—The Aboy Vidal Co. plans to build 3 warehouses, 3 stories, 100 x 150 ft. each; also docks here. A steam heating system will be installed in same. Total estimated cost, $3,000,000. J. M. Carver, 29 Broadway, New York City, N. Y., Engr.

CONTRACTS AWARDED

N. Y., New York (Borough of Bronx)—The Board of Education, 500 Park Ave., Manhattan, has awarded the contract for the installation of heating and ventilating systems in P. S. 32, to Daniel J. Rice, 103 Park Ave., Manhattan. Estimated cost, $62,797. Noted Jan. 2.

N. Y., Wards Island—L. F. Pilcher, State Arch., Capitol, Albany, has awarded the contract for installing coal and ash handling equipment, consisting of conveyor, coal hoppers, apron feeders, coal crushers, motors, etc., in the Manhattan State Hospital, to the Gifford Wood Co., Hudson. Estimated cost, $45,950.

Md., Dickeyville—The Baltimore County Water & Electric Co., 100 West Fayette St., Baltimore, has awarded the contract for the construction of a 1-story, 35 x 45 ft. pumping station, to the Price Construction Co., Maryland Trust Bldg., Baltimore. Estimated cost, $15,000.

Md., Westminster—The B. F. Shriver Co. has awarded the contract for the construction of a power plant, to J. F. Roystone Engineering Co.

Ohio, Cleveland—St. Casimir's congregation, 8223 Sowinski Ave., has awarded the contract for installing a heating system in the new 2-story church which it plans to build on East 82nd St. and Pulaski Ave., to the Price & Welker Co., 707 Canal Rd. Total estimated cost, $250,000.

Mich., Detroit — The U. S. Lighthouse Service, 341 Post Office Bldg., has awarded the contract for furnishing 2 Scotch type marine boilers for lighthouse tender "Amaranth," boilers 10 ft. 6 in. in diameter and 10 ft. 10 in. long, to the Lake Erie Boiler Works, 254 Perry St., Buffalo, N. Y. Estimated cost, $28,000.

Mich., Saginaw—The city has awarded the contract for installing 2 electrically driven pumping units, 3 transformers and accessories at the West Side water-works station, to Allis-Chalmers Manufacturing Co., West Allis, Wis. Estimated cost, $5800. Noted Jan. 7

N. D., Elgin—T. R. Atkinson, Consulting Engr., has awarded the contract for building 50,000 gal. steel tank on a 100 ft. steel tower, to James Kennedy, 97 Broadway, Fargo. Pumping machinery and wells will be installed in same. Estimated cost, $30,000.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$6.55	$7.30	Broken	$7.80	$8.55
Buck.	5.10	5.90	Egg	7.70	8.45
Rice	4.65	5.10	Stove	7.95	8.70
Barley	4.15	4.30	Chestnut	8.05	8.80

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b., Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$4.80	$3.40	$6.05	$4.30
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.50
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene,			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10, other rates p. 95.